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USE GNU EMACS

THE PLAIN TEXT COMPUTING ENVIRONMENT

Using Emacs is kind of like making a piece of art. You start with a big block and you slowly chip away, bringing it closer and closer to what you want. — *Mary Rose Cook*

[Emacs is] a Lisp Machine with several compatible user interface modalities. Which is just amazingly helpful to [blind] people like me [...] who are typically forgotten about these days. [...] Emacs is a shining beacon in a dark age of canvases and decorative user interface design. — *Mario Lang*

It wouldn't make sense to start out with anything other than Emacs. I don't think there has been a piece of software which has had a larger impact on my life. I began using this about fifteen years ago, and it has followed me across operating systems, jobs, roles (I used it to manage my teams), languages, and needs. Every time I start something new, Emacs has been there to make it just a little easier, and the more I do in it, the easier everything gets. I believe this power comes from Emacs being the closest thing we have to a working Lisp Machine. — *Katherine Cox-Buday*

Emacs outshines all other editing software in approximately the same way that the noonday sun does the stars. It is not just bigger and brighter; it simply makes everything else vanish. — *Neal Stephenson*

Emacs is the King of Editors because it's a Lisp interpreter. Each and every key you tap runs some Emacs Lisp code snippet, and since Emacs Lisp is an interpreted language, that means that you can configure any key to run any arbitrary code. You just, like, do it. — *Lars Magne Ingebrigtsen*

I'm using Linux. A library that Emacs uses to communicate with Intel hardware. — Erwin, #emacs, Freenode

OSs and GUIs come and go, only Emacs has lasting power. — *Per Abrahamsen*

I am large, I contain multitudes. — *Walt Whitman*

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Preface

This document was originally written around 1997 for GNU Emacs version 19.29 and published under the title *A Tutorial Introduction to GNU Emacs*. It has subsequently been updated for version 29.4, thoroughly revised, and expanded ridiculously. The book's version is 29.4.22 as of 29 December 2024 and is an unfinished work-in-progress.

In addition to this PDF, the book is also available in EPUB format, Kobo EPUB format, and on the web. There is an RSS feed to help you keep track of any updates to the many unfinished chapters.

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How to Use This Book

A book that tries to cover most of the enormous computing system that is GNU Emacs seems to inevitably end up about as big as Emacs itself. While I've tried to arrange the book to be readable straight through from beginning to end, I doubt many will be inclined to do so. So I've also tried to make it possible to skip directly to any topic of interest by heavily hyperlinking back to any prerequisite topics[1]. For example, if you skip to the chapter on running your shell in Emacs, you'll find the necessary links to fundamental topics you've skipped over (say, renaming Buffers, directory editing, or Incremental Search).

[1] The PDF and EPUB versions of this book contain all the links that the HTML version does, so if your reader doesn't make links obvious by default, you may want to enable that feature.

GNU Emacs has been around for 39 years, and because it debuted many concepts now taken for granted, it also has its own way of doing them, and even its own language for talking about them. So I would for sure read *The Fundamental Emacs Concepts*; *Files, Buffers and Windows in Brief*; *Selecting Text*; and *Cutting, Copying, and Pasting*; and at least glance at *The Keyboard and Key Bindings*.

The single most important thing is, while you're reading, have Emacs up and running so you can try things out as you read about them. And be sure to try the built-in interactive learn-by-doing Emacs tutorial; right now is not too soon to start it.

The Book Has an Init File

My recommendation is to learn the basics of Emacs with as few customizations as possible. However, I do provide a minimal recommended initial Init File (configuration file) that you can download and install to improve your experience. It wouldn't hurt to put this off for the first few chapters, but if you feel like bailing on Emacs before then, see if adding the book's Init File changes your mind.

Terminology and Notation

A number of Emacs technical terms are also common words. To minimize confusion, when I use the technical terms, I capitalize them. So if I say, "Killing the Frame or Window in no way kills the associated Buffer", I'm talking about three Emacs data structures. But if I say, "In this frame of reference, a window of opportunity exists to buffer your data", well, I don't know what I'd be talking about, but it has nothing to do with the Emacs data structures.

Note that in the many tables where I summarize the Emacs keystrokes for a set of commands, I don't follow this rule; instead, I try to capitalize words that might suggest a helpful mnemonic, as in this excerpt:

Keys	Action
`s h`	Show full Height in window
`s w`	Show full Width in window
`s b`	Show Both full height and width in window

There are many snippets of Emacs Lisp code in the book; a subset of them are included in the book's Init File. These snippets are labelled with a margin note like the one to the right.

Init File

One of the most basic facts about Emacs is that every key you type potentially executes some Command. When I introduce a new keystroke I use this format: `C-e` (`move-end-of-line`), which means that the keystroke `C-e` invokes the Command named `move-end-of-line`. See *The Keyboard and Key Bindings* for complete details.

I frequently mention various Unix commands and programs (often because Emacs provides an interface to them). I use the Unix Manual's traditional notation for these in a fixed-pitch font, appending a parenthesized section number to the command name. Examples are `ls(1)`, `grep(1)`, `sudo(8)`, etc.

The Scope of the Book

This book describes GNU Emacs version 29.4, which is the latest official release as of 29 December 2024; many operating systems or their package managers will come with an older (possibly *much* older) version by default. While Emacs has excellent backward compatibility, meaning everything you learn about it will probably still work for literally *decades*, it also introduces new features and new ways of doing old things all the time. If you're running an older Emacs than I am, you may occasionally find that a command or key binding that I mention doesn't exist, or acts somewhat differently; but mostly, everything will work.

There also have been and still are other versions of "Emacs" besides GNU Emacs, which can lead to differences as well. The most notable these days is probably Aquamacs, a version specially for Mac OS X, which besides its Mac-specific changes is (at this writing) based on GNU Emacs version 25.3 from 2017—that's four major revisions behind. You might ultimately prefer Aquamacs or another Emacs, but this book will be most useful to you if you start out with GNU Emacs; see *Installing Emacs*.

Additionally, some of my discussion will have a Unix focus, since that's what I use every day. Emacs works beautifully on mostly-Unix operating systems (like Mac OS X and ChromeOS) and on completely non-Unix OS's, like Microsoft Windows, but some of my examples will assume you're running a true Unix, like GNU/Linux or one of the BSDs. But really, Emacs makes all operating systems virtually indistinguishable.

My emphasis in the book is on built-in features that ship with Emacs. I occasionally mention or recommend various third-party Packages (add-ons written and provided by people like you!) but I don't go into much detail and there's no way I can keep up with the huge third-party ecosystem.

In fact, some of the most important built-in Emacs subsystems are so big that I can only give at best a glancing overview: most notable are the calculator; Gnus (for email); Org Mode (for… well… practically everything); and Emacs Lisp programming. The good news is that each of these has its own built-in book-length document (Emacs Lisp has two!).

The Fine Manual

Don't fear or neglect the extensive built-in Emacs Manual; you can start out reading it on the web but as you become familiar with Emacs I think you'll prefer reading it natively.

The more time I spent writing this book, the more I had to double-check things that I felt certain I fully understood decades ago: things that, after all, I use every day! The result was two-fold:

1. I discovered that there's a ton of new stuff I had no idea about—being an Emacs user means a lifetime of learning ahead of you (and what's better than that?).
2. I also discovered that the manual is really one of the best software user manuals ever written.

So, RTFM: Read The Fine Manual.

Audience

I'm afraid this book is of two (or more) minds about its intended audience. When I wrote the first version in 1997, the audience was librarians who were using Unix systems for the first time. When I decided to expand the book during the pandemic, I didn't want to change the audience to solely tech-savvy programmers, but I did want to include a lot of advanced stuff for tech types. The result is that those programmers will find lots of basics to skim over, and the non-programmers will find a certain amount of tech nerd stuff to skip.[2]

[2] Some Windows programmers may find a lot of Unix stuff to skip.

There are many fun and inspiring blog posts and videos by non-programming Emacs users—writers of fiction, managers, people who found a new way to organize their note-taking—and my fantasy is to find (or create!) some more, while perhaps convincing the programmers that Emacs is much more than just another IDE.

Glossary

Emacs has it's own extensive jargon of technical terms; here are some of the ones that might otherwise be puzzling.

I've also made up a few coinages of my own for the purposes of this book (labeled "KW" so you don't embarrass yourself by using them).

alias an additional, equivalent name of a function or *Command*

binding the pairing of an *event* with a *Command*

Buffer the places where text is entered, edited, or displayed

Button a *clickable* region of text in a *Buffer* that invokes a *Command*

click to activate a Button or a link in a menu or in a *Buffer*, with the mouse or by hitting Return when positioned there

Command a function intended to be used interactively by the user, rather than used only by an Emacs Lisp programmer

current line the line in a *Buffer* where *Point* (the cursor) is

cut the modern term for what Emacs calls *Kill*

delete to remove text from a *Buffer* with no way to get it back (compare *Kill*)

directory a structure on disk that holds files and other (sub-) directories; what non-Unix users call a *folder*

DWIM Do What I Mean: applied to commands that guess which of several actions are most appropriate

EIPNIF Everything Is Possible, Nothing Is Forbidden (KW); you can change any aspect of Emacs's behavior, even if it's a really bad idea

elisp Emacs Lisp, the dialect of the Lisp programming language that implements Emacs

event an action that represents input to Emacs, mainly keystrokes, or mouse-clicks or -drags

Face a font with associated styles, such as color and slant

fontification to assign Faces to certain parts of the buffer based on their structure or syntactic role

Frame an *OS*-managed Emacs window; modern term: *window*

glob to expand wildcard characters, typically in a wildcarded filename, or the special wildcard characters themselves (commonly `*` and `?`)

grep to search (after the Unix searching utility `grep(1)`)

init file your Emacs *initialization file*: what non-Emacs users call a *config file*

key binding the *binding* of a keystroke to a *Command*

Kill to remove text from a *Buffer*, saving it on the Kill Ring where it can be easily retrieved later; modern equivalent: *cut*

machine any computer, whether your laptop, desktop, or a remote server; so called by greybeards

open to Visit a file for editing

operating system the software that runs all the other software on your computer (including your phones and tablets) and interfaces with your hardware, probably one of Android, Linux, Mac OS X, or Microsoft Windows (Emacs runs on all of these)

OS *operating system*

paste the modern term for what Emacs calls *Yank*

Point the location in a *Buffer* where text would be inserted when you type

regexp a *regular expression*

Region contiguous text you're about to Kill, copy, or operate upon; modern term: *selection*

regular expression a powerful kind of wildcard, pervasively used in *Unix* and in Emacs for searching

RET means to hit the Return or Enter key

selection the modern term for what Emacs calls the *Region*

session the period of time from when you start Emacs to when you exit it; may literally span months

subsystem a collection of Commands and Modes that together facilitate a coherent activity (KW)

Unix the *operating system* on which GNU Emacs was developed; comes in many flavors, of which Linux is perhaps the best known

Visit to load a file into Emacs for editing; modern term: *open*

Window a division of a *Frame*; modern term: *pane*

Yank to insert previously Killed or copied text; modern term: *paste*

The Emacs manual also has a glossary, and the Emacs Wiki has both a glossary page and a jargon page.

Part I

FUNDAMENTALS

Introduction

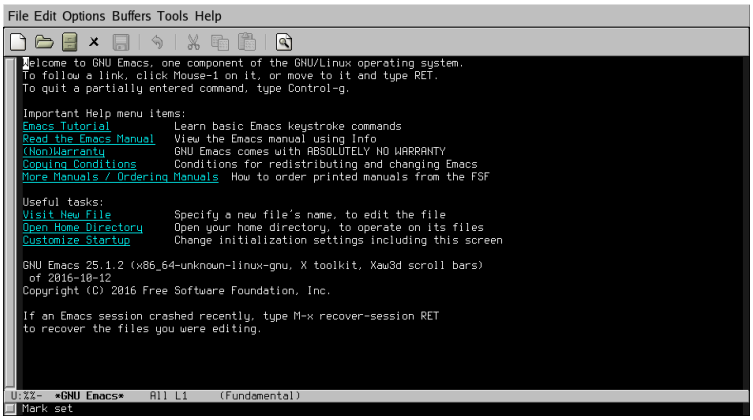


Figure 1: Emacs Splash Screen

What GNU Emacs Is

GNU Emacs is a free, portable, extensible, internationalized, self-documenting text editor. That it is *free* means specifically that the source code is freely copyable and redistributable, so Emacs can never be discontinued and disappear. That it is *portable* means that it runs on many computers under many different operating systems, so that you can probably count on being able to use the same program no matter what computer you're using. That it is *extensible* means that you can not only customize all aspects of its usage (from keystrokes through fonts, colors, mousage and menus), but that you, and the community, can modify and program Emacs, *even while Emacs is running*, to do entirely new things that its designers never thought of. That it is *internationalized* means that it has full Unicode[3] support, including bidirectional text and many input methods for non-Latin scripts. That it is *self-documenting* means that every keystroke, menu item, and function can thoroughly explain itself and its usage, and that Emacs contains 418,338 lines of hypertext reference manuals and tutorial documentation about itself and its subsystems.

[3] And support for many non-Unicode coding systems and languages, including Chinese-BIG5, Chinese-CNS, Chinese-GB, Cyrillic-Alternativnyj, Cyrillic-ISO, Cyrillic-KOI8, Devanagari, English, Ethiopic, Greek, Hebrew, Japanese, Korean, Lao, Latin-1, Latin-2, Latin-3, Latin-4, Latin-5, Thai, Tibetan, and Vietnamese. ISO-2022 is supported, so you can combine different coding systems in the same file.

Because of all this, GNU Emacs is an extremely successful program (having been in continuous development for 39 years[4]), and does more for you than any other editor. It's particularly good for programmers. No matter what programming language you use, Emacs probably provides a *mode* that makes it especially easy to edit code in that language, providing syntax highlighting, context sensitive indentation, and layout. It also allows you to compile your programs inside Emacs, with links from error messages to source code; debug your programs inside Emacs, with links to the source; interact directly with the language interpreter (REPL); jump across multiple files to the definition of a symbol in your source code; and interact with your version control system[5].

[4] As of 2024; the original Emacs, GNU Emacs's predecessor, dates back almost 10 years earlier, to 1976; while GNU Emacs was a complete reimplementation, the two programs are conceptually identical.

[5] Whether Git, Mercurial, Fossil, GNU Arch, Bazaar, CVS, Monotone, RCS, SCCS/CSSC, or Subversion.

Emacs also provides many built-in applications such as:

- mail readers (at least half a dozen)
- web browsers (at least two)
- a powerful file manager like Windows Explorer (File Explorer) or Apple's macOS Finder
- interactive shells, logins (ssh, ftp, sudo), and terminal emulators
- a powerful and easy to use macro system to automate your tasks
- diffing and merging of files
- calendars, project planning, TODO lists, scheduling, and agendas
- a powerful infinite precision programmable calculator with symbolic algebra and data graphics
- image, PDF, DVI, ebook (EPUB), OpenDocument, Microsoft Office, and PostScript viewers, and inline images in plain text
- typesetting and publication of text or source code to HTML, PDF, and presentation slideshows (this document is an example)
- literate programming
- interactive notebooks: that is, documents that contain live code, data, equations, visualizations, and text
- client / server mode (connect to a running local Emacs from any terminal, or to a remote Emacs running on a different computer)
- multilingual spell checking, dictionaries, and thesauri (available in all of the above applications and subsystems, too)
- transparent editing of encrypted and compressed files, and of files inside containers (like tar and zip archives)

- remote file editing (any file or directory you want to edit can be transparently accessed via ssh, ftp and the like)
- spreadsheets (three)
- music players (at least half a dozen)
- chat / messaging systems (like IRC, Jabber, Slack)
- a window manager for X windows
- native Emacs games and interfaces to external games
- a Rogerian therapist (in case this is all a little overwhelming)

In addition, Emacs's extensibility has resulted in a vibrant ecosystem; users share packages that provide new functionality, and it's easy to browse several thousand of these via the built-in package manager, and install the ones of interest. Many more Emacs packages are available on GitHub and in the Emacs Wiki.

Figure 2: Emacs as Operating System

The image above shows Emacs "in use". It's a little unrealistic in that I, at least, never want that many windows open simultaneously, but it's a real screen shot. Going across the columns from left to right, we have email (a folder and a message) and an agenda from my project planner; OCaml source code with a compilation error message and a type-throwback window; a Google search in one of Emacs's web browsers above a PDF; and finally, a directory in the file manager, a shell, and a paused game of Tetris.

At the very bottom of the screen, I'm in the middle of typing an Emacs command by its name (`M-x list`), and have hit `TAB` to get completion — the completions window has temporarily popped up and spans the width of the screen.

In the grey mode line along the bottom of the completions window (and replicated, albeit truncated, in slightly different form at

the bottom of every other window) you can see that I have incoming email that I haven't yet seen (red envelope icon) and an unseen chat message from someone named "Tex".

What GNU Emacs Is Not

First and foremost, Emacs is not a WYSIWYG word processor. This is because Emacs leverages plain text to get maximum flexibility and avoid lock-in to opaque file formats. But Emacs is also used to edit and typeset documents by people who use document preparation systems and markup languages like LaTeX, Markdown, and Emacs's own Org markup language[6].

Actually, this is about the only thing I can think of that GNU Emacs is not.

[6] This document is written in Org; the HTML, PDF, and EPUB versions are generated from the Org source code.

Emacs as Operating System

Emacs is one of those rare pieces of software that can change your computing life. It's not really a text editor, nor an IDE. It's really the last remaining Lisp Machine, a synergistic system that you live in, which replaces most of the dozens of single-purpose applications you'd otherwise be using, some of which lock you into black-box file formats or corporate licensing.

The more things you do in Emacs, the more those things multiplicatively enhance each other.

Imagine you use Emacs (as I do) for your document creation, web site publishing, interactive development environment (IDE), email, TODO lists, file manager, web browser (sometimes), shells and terminals, calendar and agenda, and chat system. As a result, in all of these:

- you use the same exact completion system (with history), whether entering command names, file names, email addresses, or web urls
- you search with the exact same regular expression syntax and the same keystrokes
- you can copy any text from anyplace[7]
- you can search across all or a subset of the windows running these applications ("which window did I see that error message in?"; "which browser tab is that text in?")
- you can dynamically highlight lines and words in various colors to make them stand out or distinguish between them
- you automate tasks within and across all these systems with the same macro facility
- you have the same spellcheck interface and dictionaries
- after a restart (we all have to reboot occasionally), you can have most of these windows and files come back with everything (down to your cursor location) exactly where you left it

[7] How many times have you had to take a screenshot of an error message from a GUI application because the text wasn't copyable?

- you configure and customize all these applications in the same configuration language (and in a single file, unless you choose to split it up), and the language is a complete programming language
- you can modify, extend, fix bugs, and generally hack all of these applications, live, while they're running
- you can program entirely new applications by combining functions and elements from any of the others

Emacs insulates you from the operating system. If you full-screen your Emacs, you will barely be able to tell whether it's Linux, BSD, Mac OS, Windows, or ChromeOS underneath. You can use the same configuration everywhere, and since the config language is Lisp, you have conditionals to make any OS- or computer-specific tweaks that might be necessary. You can even load your config over the network — from a web page if you like.

Quickstart

Installing Emacs

If you are running Unix, Emacs may already be installed. If not, it will certainly be easily installed via your package manager.

Arch Linux	`sudo pacman -S emacs-nativecomp`
Debian	`sudo apt-get install emacs`
Fedora	`sudo yum install emacs`
Ubuntu	`sudo apt-get install emacs`

When I last used Mac OS X, Emacs came preinstalled, but was *very* out of date. You could install an up-to-date version via one of the Mac's many third-party package managers (such as Homebrew), but I recommend David Caldwell's Emacs For Mac OS X[8]; it's always up-to-date, and, as Caldwell says, is "Pure Emacs! No Extras! No nonsense!". I would discourage you from using Aquamacs, which attempts to make a more Mac-like Emacs but ends up rendering it painful to use (IMHO).

[8] `https://emacsformacosx.com/`

If you are running Microsoft Windows, I recommend the Free Software Foundation (FSF)'s Windows build, available from the download page[9]; note that on Windows, instead of running the `emacs` executable, you want to run the `runemacs` script instead; a Windows user will probably be most comfortable dragging it the task bar. You can also install Emacs in the Windows Subsystem for Linux (WSL); just follow the instructions above for whatever version of Linux you chose. See the Appendix for how to install Emacs on a Chromebook; you can even install Emacs on your Android phone.

[9] `http://www.gnu.org/software/emacs/download.html`

For the cheapest possible complete Emacs computing environment, you can run Emacs on a $130 Raspberry Pi 400 that comes with a keyboard, mouse, and cable to connect to your TV.

And, since Emacs is free software, you can of course download and compile your own copy from source.

Starting Up and Running Emacs

Emacs can run in two different modes: a graphical version, which requires a window system like X11 (or the Mac or Windows native interface), and a "text-only" terminal version, like old-school Unix programs such as `vi` or `vim`. I say you should run the graphical version; in the terminal version (forced via the `-nw` ("no windows") option if a window system is running), you won't be able to display images or combine multiple fonts, and many useful key combinations will be impossible to type, requiring clunkier alternatives[10]. Mouse-button and -motion combinations will be severely limited.

Note that using the graphical version doesn't imply working in a GUI style with heavy mouse action; I never use the mouse, and configure my Emacs so that the graphical version looks like `Emacs` in a terminal (right down to my beloved fixed-pitch font). However, because I'm running the graphical version, I get better font and character set support, can view images and PDFs, and make use of all the exotic keys on my keyboard. If what you like about an editor such as `vim` is the way its invocation is tightly bound to your shell and working directory, or its fast startup speed, running the graphical Emacs in client / server mode achieves exactly the same thing.

Unless you go out of your way to change this (e.g. with `-nw`), the graphical version is what you'll get if you invoke Emacs from an X11, Mac, or Windows desktop launcher, or from a shell in a terminal under one of those desktops. This book everywhere assumes you're running the graphical version.

[10] In particular, `C-h`, the very important Help character, will probably be taken as `Backspace` and will delete characters; the function keys may or may not work for you (if they do, you can use `F1` for Help); and possibly nothing will work as a Meta key (you can use the Escape key instead).

Entering Emacs

To enter Emacs, you just say:

```
emacs
```

on the command line, or invoke it from your desktop via a launcher, menu, or icon[11]. When it comes up, you won't be editing any file. You can then use the file commands to read in files for editing. Alternatively, you can fire up Emacs with an initial file (or files) by saying:

```
emacs foo.py
```

Note that for many Emacs users, starting Emacs is something that's done very rarely: I only do it when I've needed to reboot my computer. You don't use Emacs the way you use `vim`, starting it in a shell to edit one file, then exiting to compile, then lather rinse repeat. Loading and unloading files, compiling, debugging, file management, version control, and everything else is done inside Emacs with special commands that provide very tight and seamless integration.

[11] If you like dark themes (what we used to call "reverse video"), as in all the screen shots in this book, you can add the `-rv` option; later you can make that your default, or choose one of many other dark themes.

If you really *prefer* to work in a many-sessions, multi-terminal style after trying the native Emacs approach, the way to do it is via client / server mode: start up an Emacs server, and then repeatedly run `emacsclient` in your terminals as you navigate around, just the way you'd run `vim`.

Exiting Emacs

You can exit Emacs from the menu via File / Quit, or type the two keys *Control+x* followed by *Control+c* (which we write as `C-x C-c`). If you've made any changes to a file, you'll be asked if you want to save them.

What Emacs Looks Like

The Screen

If you started up Emacs without loading a file, you'll be looking at the *splash screen* [12]; this is not something you'll see in everyday use. Otherwise, you'll be looking at your file.

The default Emacs screen looks pretty conventional, if old-fashioned: it has a menu bar at the top, a toolbar beneath that, and a scrollbar on the left (you can ultimately disable any of these; I have, and my Emacs has the clean retro look of `vi`); the rest of the screen is completely devoted to the text of your file, except for the bottom line of the screen — the *echo area* — and the line above that — the *mode line*.

[12] The splash screen has some helpful hints and clickable links (in underlined cyan); you can click them with the mouse, or navigate through them with the Tab key and use Return (Enter) to execute them.

The Mode Line

The Mode Line displays some essential information, in particular the name of the file you're editing and whether or not you've modified it, what line you're on, and what Mode you're in. It's completely customizable and can show lots of other information too, such as the time, load average, mail availability (biff), and version control status. See *The Mode Line in Detail* below.

The Echo Area

The blank line below the mode line is the *Echo Area*. The Echo Area is used by Emacs to display short messages, and also for input when Emacs is prompting you to type something (it may want you to type yes or no in answer to a question, the name of a file to be edited, the long name of a command, etc). Unless you are actively using the mouse, Emacs will typically *not* use a modal dialog box for this sort of thing.

Using Emacs Like It's Notepad?

Emacs has a reputation of being difficult to use, but in fact anybody can readily use Emacs out of the box with no instruction[13] by using the menu bar and toolbar. Simply choose File / Open File from the menu; for common programming languages, you'll see syntax highlighting automatically. Navigate conventionally with the scrollbar, mouse, and the Page Up, Page Down, and arrow keys. To insert text, just start typing (Emacs isn't modal like `vim` (not by default, anyway[14])); delete text with Delete or Backspace. Finally, choose File / Save and then File / Quit from the menu.

This ought to sound *extremely* familiar.

And pretty boring. You may not be impressed, but you'll be able to get a lot of work done right away.

But if you want to use Emacs efficiently and give it a chance to change your life, you need to learn to control it the way it was originally designed: via the keyboard.

The enormous Emacs keyboard command set is indeed daunting. Fortunately, you can learn the keystrokes incrementally, using the menus for things you don't yet know how to do. Eventually, you may stop using the menus entirely; I turned off the menu bar, tool bar and even the scroll bars years ago to save screen real estate and haven't missed them.

[13] Try that with `vim`...

[14] If you like `vim`'s modal command framework, Emacs has an extremely powerful `vim` emulation called Evil.

Configuring Emacs

Don't. Yet. Emacs is all about customizing and making it act the way you want, but in my opinion, you should learn the basics in a stock, mostly uncustomized Emacs, so that if you have questions or problems and look up an answer, that answer will apply to you.

In recent years, there's been something of a cottage industry in Emacs "starter kits" (such as *Prelude*, *Doom Emacs*, *Emacs Starter Kit*, *Spacemacs*, etc[15]): distributions that give you a heavily pre-customized, sexy-looking Emacs to fix what are perceived to be "old-fashioned defaults" and load and start up everything you could conceivably want. I would avoid these at first for the same reason[16]. In fact, some of these starter kits change so much about the experience that large parts of this book will appear to be completely inapplicable to you, so bear that in mind.

I hope browsing this book will convince you that there's great stuff to come, and that therefore you'll be able to resist immediately adding a million bits of other people's configuration tweaks and third-party packages for just a little while, until you get up to speed with the basics.

[15] Prelude is probably the least intrusive of these.

[16] Though if the "old-fashioned defaults" seem unbearable to you, trying a starter kit is better than giving up!

However, there *are* a few places where I do recommend some customizations that I think make a significant improvement to the Emacs experience, even while you're learning. These will pop up from time to time, with a margin note that says "Init File", like the one to the right, and are all collected together in an appendix.

Init File

My own Emacs is so heavily customized from decades of use that I can barely function in a stock Emacs! I'm all in favor of customizing[17], but don't jump in too early.

In a recent thread on the help-gnu-emacs mailing list[18], the question came up as to what was the size, in *lines of code* (*LOC*), of the typical long-time Emacs user's Init File. There were about a dozen answers. The figure shows the result of this impromptu and unscientific poll[19]; there's quite a range from the smallest (this book's Init File) to the largest; the median size is 2,500 lines.

[17] Before I declared Init File Bankruptcy in 2018, my 70K init file comprised 1,874 lines of Emacs Lisp, so I think it's safe to say I'm not against customization. (My new init file is about half as big.)

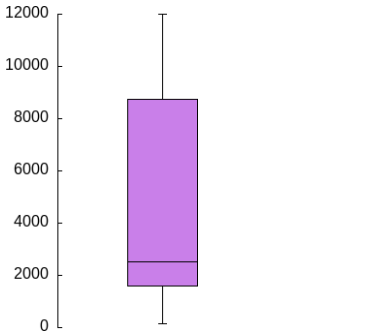


Figure 3: Init File LOC of Some Experienced Users

[18] See *Mailing Lists*, below.

[19] I've included my own current Init File, my pre-Bankuptcy Init File, and the starter Init File I recommend in this book.

The Built-In Emacs Tutorial

If you want to dive in immediately and start using Emacs as it ought to be used, now is a good time to run the built-in learn-by-doing Emacs tutorial. This is a simply a special text file that explains some basic Emacs commands and has you try them out, explaining how to get back to where you were and continue. It's very effective and you don't have to finish it all at once — it'll remember where you left off for next time.

If you fire up Emacs without a filename and are looking at the splash screen, you'll notice that your cursor is sitting right on a "clickable" button labeled "Emacs Tutorial" — just hit return or click the label with the mouse and the tutorial will start up.

If you aren't looking at the splash screen, you can start (or continue) the tutorial at any time by typing `C-h t` (that's *Control+h* followed by the letter *t*). If you type instead `C-u C-h t` Emacs will ask what national language to use for the tutorial; it's available in twenty-three languages: Brazilian, Portuguese, Chinese, Czech, Dutch, English, Esperanto, Farsi, French, German, Greek, Hebrew, Italian, Japanese, Korean, Polish, Romanian, Russian, Slovak, Slovenian, Spanish, Swedish, Thai, and Ukrainian. The default is to use the language of your computing environment, if available.

The Fundamental Emacs Concepts

To really make Emacs work for you requires an appreciation of its fundamental concepts and how they work together to form a synergistic system.

Functions

Everything you do in Emacs involves the invocation of functions[20] and these functions take arguments and have help and documentation.

[20] You could say this is true of any program, but the Emacs user is always aware of this, while the non-Emacs user doesn't usually think about it at all.

The Keyboard and Key Bindings

Most of the time you invoke these functions with simple keystrokes — even just typing a single letter into a file invokes a specific function, as do all the editing operations (like deleting a word), and all things like opening files or setting a reminder or sending an email. Most of these functions are associated with keystrokes in a malleable, context-sensitive hierarchical organization with an (at least aspirational) mnemonic scheme.

Variables

Emacs also contains *variables* exactly like those of any programming language, which store a huge variety of data. Most of them are used only by programmers, but a subset of them are *Customizable Variables* (a.k.a. *User Options*), which you'll use to configure Emacs to your liking. These variables aren't something that you just set up once in a configuration file: you'll soon be comfortable setting and inspecting them on the fly as you're using Emacs.

Discovery, Help and Completion

No one wants to memorize all the thousands of Emacs key bindings[21], including those they might use only weekly or monthly. Less

[21] At startup, a fresh Emacs has 1,988 key bindings available.

frequently used functions are invoked by name with a powerful and extensible completion system, unknown functions are discovered with the Apropos facility, the Help system tells you how to use them, and the Info hypertext documentation system provides even more complete discursive documentation (and there's a clickable link from the help for any function to its source code, if you really want to know what's going on).

Buffers

The text of any file you're editing is stored in a *Buffer*. But so is almost everything else: documentation, error messages, and the user interfaces (UIs) to the many Emacs subsystems (file managers, email, REPLs, etc). This means that to a great extent you can manipulate a UI using the same commands you use to manipulate the text you're editing, which is very powerful and means you have less to learn. You can have an arbitrary number of Buffers in your Emacs at any time.

Plain Text

The power of the Buffer is due to the fact that Emacs prioritizes plain text. Almost everything you see in Emacs is plain text. This doesn't mean everything *looks* plain; the typical Emacs Buffer is colorized, uses a variety of fonts and possibly character sets, and may include "clickable"[22] buttons, read-only sections, dynamically updating data, icons and full-size images, and more: but the Buffer still consists of plain text and the enhancements are applied on top of it.

[22] When I say "clickable" in this document, I don't specifically mean "with the mouse" (though you can do that if you like); rather I mean positioning your cursor at some location and "activating" it (typically by hitting Return). Emacs is full of clickable text locations that provide links to other locations and various other actions.

Windows

Windows are the viewports into your Buffers. You can have an arbitrary number of open windows at any time, divided up horizontally and vertically, and Emacs acts like a tiling window manager to manage them for you.

Search

Emacs has a very wide variety of search commands which do more than simply find the next occurrence of "foo" in your file. You can search within a Buffer, across multiple Buffers, across files that aren't loaded into Emacs yet, and across the web. You can search back in time by searching version control history. You can search more than just files: since Emacs subsystems (like calendars, shells, and email)

run in Buffers, you can search their user interfaces and outputs. You can search all the Emacs documentation, and you can search for things by their names as well as by what they contain. Searches can take you directly to a match or pop up a Buffer of all the matches (rather like a page of Google search results), from which you can jump to the actual locations. All these searches come in a flexible variety of modes (fixed text, lax spacing, case- and diacritic-folding, word search, regular expression, and more), and since you're doing all this searching in Emacs rather than in a dozen distinct programs, they share the same options and syntax.

Undo and Redo

While common now, unlimited Undo with redo probably debuted in Emacs in the early 1980s. You can undo all changes (even back through file saves) and redo them (undo the undo) all the way forward again, in any combination (you can undo the redo of the undo of the undo). Undo is smart in that it groups togther tiny changes (e.g. consecutive single-character insertions) to make undoing less tedious, and commands that make big structured changes (like search-and-replace) arrange for undo to happen in sensible units. There's an alternative Undo that works in a tree-structured manner. Most powerful is that you can mark off a specific subregion of the Buffer, and then undo only the changes made within that region (even if you've since made other changes elsewhere).

Major and Minor Modes

Every Buffer has a *Major Mode* that's specialized for some particular sort of text. The specializations typically affect the visual display of the text, tweak general-purpose commands to better suit the text, and provide key bindings for new commands written specifically to work with that kind of text. The classic case is a Major Mode for editing the source code of a given programming language — for example, the mode specializations of `python-mode` turn Emacs into a Python IDE.

In addition to *Major* Modes, we also have *Minor Modes*. A Major Mode implements sweeping specializations — you wouldn't want to edit HTML in `python-mode` — but Minor Modes are like mix-ins: each Minor Mode implements some sort of tweak to behavior or appearance that's usually suitable to add to any number of Major Modes. While any Buffer has exactly one Major Mode, you might turn on a few dozen Minor Modes as well. Minor Modes can implement additional varieties of navigation, formatting, indentation,

highlighting, templating, diagramming, spellcheck, footnotes, tables, outlining, text folding, hypertext linking, and much more.

My Emacs at the moment has 662 major and minor modes ready to be enabled.

Customization

One of the hallmarks of Emacs is that virtually every aspect of it can be customized. Not only can you customize fonts, colors, and keystrokes but you can customize them all differently in different parts of Emacs (one font set for Python, another for Haskell). Conversely, if you use Emacs for your email and someone mails you a snippet of Python, you see it, in the email, colorized according to your preferences. Emacs customization is sometimes thought of as unfathomable unless you're a Lisp programmer, but for decades Emacs has had an interactive forms-based customization system (called Customize) that lets anybody easily tweak anything.

Programmabililty

But if you *are* willing to learn a little Lisp (or a lot), you can also customize Emacs in the programming language that it's implemented in, Emacs Lisp (a.k.a. *Elisp)*; having used Emacs since before the Customize system existed, I still do all my customizations this way.[23] But with Elisp you can go well beyond mere customization: you can add completely new features to Emacs that never existed. This could range from three lines of code to add an idiosyncratic way of scrolling text (I've defined a keystroke to scroll by paragraphs) to building large software systems that would, in a non-Emacs universe, be standalone applications. The popular Magit front-end to the Git version control system comprises 30,000 lines of Elisp code. Gnus, one of several Emacs mail readers, comprises 117,485 lines! Emacs itself is about 79% Elisp (the rest being a C core that implements the Lisp interpreter).

[23] But I'm trying to get with the program: it's worth it.

Note that Emacs Lisp isn't an ad hoc scripting language invented for use in just one editor. It's a dialect of the famous programming language Lisp, which means it has a decades-old well-designed syntax and semantics. It's a *real* programming language: in addition to the multiple books and articles written about Elisp, you can also learn from the hundreds of books and articles written about Lisp itself. And, what you learn about Elisp sets you on the way to becoming a real Lisp programmer.

But if you're not interested in learning Lisp, you can still program your Emacs via the incredibly powerful macro system called

Keyboard Macros. You simply start defining a macro, perform a sequence of editing actions (e.g., search for a keyword, capitalize it, delete the next two words, and add another word at the end of the line), then indicate you're done. Now a keystroke runs the macro to repeat those actions. Once you're convinced it's working, you can tell Emacs to repeat the macro until it's processed everything. Macros aren't limited to operating on just one Buffer: you can use any Emacs commands in defining one, and so can switch Buffers mid-macro at will.

But Emacs goes well beyond the capabilities of most macro systems. Since invoking an external shell command is a basic capability of Emacs, you can do that in your macro and use the result. You can have many macros defined at once. You can edit your macro (rather than having to redefine it) if you discover it's not quite right. You can save your macro with a name for use in future Emacs sessions. A macro can count (to do things like numbering). It can ask for confirmation of a step, or allow you to do a localized tweak at each invocation. All this without being a programmer.

Free Software

Finally, GNU Emacs is *free software*. This doesn't mean that you don't have to pay for Emacs (though you don't). It means that the project is built upon what the Free Software Foundation (FSF) calls the "four freedoms" — the freedom to (0) run the program, (1) study and change the program in source code form, (2) redistribute exact copies, and (3) distribute modified versions. The FSF achieves this via the frankly amazing invention of the *Copyleft license*. Without it, Emacs probably wouldn't exist as the long-lived, continuously improving project that it is. And it assures that Emacs can never be taken away from you by any corporate entity.

The Keyboard and Key Bindings

> It makes sense for someone who spends most of their time manipulating text to learn a group of obscure key combinations. It saves time and increases productivity. Learning to use Emacs properly reminds me of playing Jazz on the piano. I've learnt all those chords and runs and fills so that I can use them without thinking when I'm improvising. Likewise, I've practised using Emacs key strokes such as `M-f`, [`M-c`] and `C-M-<Space>` so often I use them without thinking when editing. I rely on `M-/` to complete words, and I can't do without `M-h` and `C-e` to select and move around text. — *Tony Ballantyne (SF and Fantasy Writer)*

For Emacs, every keystroke is actually a command (i.e., a function that does something), even simple keystrokes like the letter A: printing characters like this are commands to insert themselves into your text. Non-printing characters (like control characters) are editing commands, which might move the cursor, scroll some text, delete or copy text, rename a file, initiate sending an email, etc.

Every command has a long name, which you can look up in the documentation, like `kill-line`, `delete-backward-char`, or `self-insert-command`. Many commands are bound to keystrokes for convenient editing. We call such a pairing of keystroke and command a *key binding*, or *binding* for short.

The set of all bindings make up the Emacs command set. However, Emacs is an extensible, customizable editor. This means that:

- bindings can be different when editing different types of text, by virtue of extensibility
- bindings can be different for different users, by virtue of customizability

In this document I describe the standard, uncustomized, Emacs key bindings.

Notation

I use the standard Emacs notation to describe keystrokes:

`C-x` For any *x*, the keystroke *Control+x*.

`M-x` For any *x*, the keystroke *Meta+x* (see below for more details on Meta keystrokes).

`C-M-x` For any *x*, the keystroke *Control+Meta+x* (which is exactly the same as *Meta+Control+x*.).

`S-x` For any *x*, the keystroke *Shift+x*

`s-x` For any *x*, the keystroke *Super+x*[24]

`RET` The return key.

`SPC` The space bar.

`ESC` The escape key.

[24] The *Super* key is the "other modifier" on your keyboard. It's usually right next to your Meta key. See *The Troublesome Meta Key*.

Control, Meta, and Super are *modifier keys*, i.e. they only take effect when held down *simultaneously* with another key, exactly like Shift. If you hold down Shift, Control, or Meta alone, and then simply release it, Emacs doesn't even know you've done so: you must add a non-modifier key for the combination to register as a keystroke. You can combine as many modifier keys together as you have fingers for.

Your keyboard may have even more modifier keys. Emacs is aware of these other modifiers but doesn't have any standard bindings that use them (you can use them for your own purposes though). In fact, because of arbitrary differences between the keyboards of different computer manufacturers[25], Emacs's Meta modifier really stands for "your preferred non-Control modifier key".

[25] While these differences have a historical basis, today they really come down to Apple versus everybody else. These differences are utterly beyond Emacs's control.

We don't typically mention Shift as a modifier key, usually just writing `X` instead of `S-x`, and only use the `S-` notation occasionally for disambiguation or emphasis. The `S-` modifier can of course be combined with other modifiers (e.g. `S-M-x`, which is equivalent to `M-X`, or `S-C-M-5`, which is equivalent to `C-M-%`). Unless you choose to make a distinction with a custom binding, Emacs almost always equates a shifted letter in a keystroke with the lowercase version of the same keystroke: so for example both `M-f` and `M-F` (a.k.a. `S-M-f`) are equivalent: both invoke `forward-word`. See *Shift Selection* for the only major exception.

Simple Keys

There are 94 different basic printable characters[26], and they are all bound to `self-insert-command` so that they insert themselves as text when typed. For editing commands, Emacs uses all the control characters: `C-a`, `C-b`, etc. But this is only 32 characters, and Emacs has more than 32 editing commands.[27]

[26] These are basically the characters on the keys of your keyboard: letters, digits, and punctuation; see *What Is Text?*

[27] There's also `C-A` (a.k.a. *Shift+Control+a* or `S-C-a`) which is a distinct keystroke (when running in graphical mode), but to keep things simple the upper-case control characters are by default equated to the corresponding lowercase control characters. The same is true of the upper-case metacharacters, etc.

To provide access to more key bindings, Emacs uses a *Meta* key[28]. This gives us access to keystrokes such as `M-a`, `M-b`, etc.

Since Control and Meta are both shift-like modifier keys, what happens if you hold down both and then type a key? These combinations are valid keystrokes as well; they are notated `C-M-a`, etc. Because both Control and Meta are modifier keys, `C-M-a` must necessarily be the same keystroke as `M-C-a`. For consistency we always write the former.

Modern keyboards also offer a wealth of non-printing keys such as the home key, the four arrow keys, and the function keys (F1 and so on). Emacs also binds commands to many of these. The notation we use for these keys looks like `<home>` for the home key, `<down>` for the down arrow, `<f1>` for the first function key, and the like. Emacs can also distinguish the keys of a numeric keypad (whether NumLock is on or off.) These keys can all be combined with modifier keys to form keystrokes like `C-M-<down>`.

Here are the Emacs spellings of some of the most commonly used non-printing keys on your keyboard.

`<prior>`	PgUp (Page Up)
`<next>`	Pgdn (Page Down)
`<home>`	Home
`<end>`	End
`<left> <right> <up> <down>`	← → ↑ ↓ (arrow keys)
`<return>`	Enter or Return (also spelled `RET`)
`<tab>`	Tab (also spelled `TAB`)
`<backspace>`	Backspace (translated to `DEL`)
`<delete>`	Del or Delete
`<insert>`	Insert
`<f1>` etc	F1 function key

[28] What key is the Meta key? On standard keyboards, it will be either the Alt key or the Windows key. On Apple keyboards, it will be either the Option key or the Command key. See *The Troublesome Meta Key*.

Prefix or Compound Keys

The Control and Meta keys plus the printing characters give us 256 possible keystrokes[29], or 160 editing commands after eliminating the self-inserting characters. But Emacs has many more than 160 commands! To handle this we also use *prefix commands*. A prefix command is a keystroke that, when typed, waits for another keystroke to be typed, making a pair (sequence) of keystrokes bound to one command. Each prefix command adds another 256 keystrokes that we can bind commands to. Prefix commands often group together commands that are somehow related.

The most important prefix commands are:

`C-h` The *help* prefix, used for Help commands; the function key `F1` is

[29] Really more than 256, since Emacs (in graphical mode) can bind to keys like Insert, Print Screen, the function keys…

equivalent.

`C-x` The *extra* prefix; this prefix is used mostly for commands that manipulate files, buffers and windows.

`C-c` The *context-specific* prefix. Used for commands that are specific to particular Modes, so they are free to be used for different commands depending on context. This prefix also reserves a set of keystrokes specifically for the user to use for their own purposes. These are the most variable of Emacs commands.

These three prefixes give us another 768 keystrokes, for a total of 928. But Emacs has far more than 928 commands! To handle this, you can bind one of the subcommands of a prefix command to another prefix command, like `C-x 4` for example, or `C-x v`, each such binding yielding potentially another 256 keystrokes. A number of these two-character prefixes exist, but they're rather specialized, and don't contain a full set of 256 commands (usually there are only a few, and the prefix is just used for a mnemonic grouping). There are even three character prefixes, but most people won't admit to using them.

Table 1: Some More Prefix Keys

Prefix	Bindings	Commands
`C-h`	40	Help commands
`<f1>`		An alias for `C-h`
`C-x 4`	15	Other-Window commands
`C-x 5`	15	Other-Frame commands
`C-x 8`	185	Unicode character insertion
`C-x 8 e`	9	Emoji insertion
`C-x @`	6	Keyboard Event commands
`C-x RET`	11	Coding System commands
`C-x a`	12	Abbrev commands
`C-x n`	5	Narrowing commands
`C-x r`	27	Rectangle, Register, and Bookmark commands
`C-x t`	20	Tab Bar commands
`C-x v`	25	Version Control commands
`C-x w`	6	Window commands
`C-x x`	7	Buffer commands
`M-g`	9	Goto commands
`M-s`	8	Search commands
`M-s h`	7	Highlight commands
`<f2>`	4	Two-Column commands
`C-x 6`		An alias for `<f2>`
	411	

Aborting a Command

What if you start typing a prefix, like `C-x`, and then decide you didn't mean it? Emacs will be sitting there, showing this in the Echo Area:

```
C-x-
```

waiting for you to finish. You can abort this partially completed prefix by typing `C-g` (`keyboard-quit`).[30]

You can also interrupt a command that's asking you a question, or for information (like a file name): if you type the command to open a file and it's asking you for the filename, but you've changed your mind, `C-g` will abort it. It will also interrupt a running command that you want to now stop. Perhaps you're editing a file and have initiated a search-and-replace operation, and after several replacements, you see it was not what you wanted: `C-g` will interrupt it in the middle (and, of course, you can then Undo what you'd already done).

[30] `C-g` is the ASCII Bell or Alert character, originally meant to make a teletype beep, so it sort of makes sense as the interrupter (especially since Emacs beeps when you type it).

Using Extended Commands

By now we've entered a sort of rarefied atmosphere: even the most hardcore Emacs nerd doesn't really use all these key bindings. Some Emacs commands are used very rarely, and, when you need one, it's easier to invoke the command by typing its long name directly, using the Completion system to remind you of the precise name.

There's one Emacs command that can be used to execute any other command by typing its long name: `M-x` (mnemonic: "eXecute" or "eXtended"). When you type `M-x`, Emacs prompts you, in the Echo Area[31], for the name of any command (with Completion), even if that command is bound to one or more keys already, and then executes it.

[31] Technically, the Minibuffer.

The prompt looks like:

```
M-x
```

and the completion works rather like that of any Unix shell, by typing an initial part of the command and hitting `TAB`[32]. So you might type:

[32] Completion is actually much more sophisticated than this; see *Completion* for details.

```
M-x backw
```

and hit `TAB` at that point; Emacs will partially complete this to:

```
M-x backward-
```

and if you then type:

```
M-x backward-sen
```

and hit another TAB, it will complete the entire command (because the prefix is now unambiguous):

```
M-x backward-sentence
```

Now you can hit return (RET) to execute the command or if that's not what you meant, you can edit what you've typed (using any Emacs editing commands) and keep completing as you go; of course a C-g will abort the M-x.

If you hit TAB again at the point at which you've achieved a partial completion (at the point of backw or backward- or backward-sen above), Emacs will pop up a transient buffer showing all the possible completions (you may discover some surprising and interesting-sounding commands this way).

This can be a lot of commands! If you type M-x and immediately hit TAB, Emacs will pop up a buffer showing *all* the interactive commands that exist at the moment. In a stock Emacs, freshly started, this will be over 4,000 commands; in my current Emacs session, with many third-party packages loaded, I get about 8,000.

When you see something like " M-a (backward-sentence)" in this book, it means that the keystroke M-a is bound (by default) to the command backward-sentence (in most Modes, or in the Mode I'm currently talking about), and so at any moment you can use M-x backward-sentence or M-a, as you prefer.

Too Many Commands?

How does anyone remember these 4,000 commands? Simple: you don't. Every Emacs user knows a different subset of commands. I've used Emacs for 45 years (starting with the original TECO Emacs), and I learn useful Emacs commands that are new to me all the time. Often I notice another Emacs user doing something and I have no idea how they've done it, so I ask and learn some Emacs command that I just never came across, or never developed as a habit, or once knew and forgot!

Some Emacs users just learn the most basic commands and are completely happy. Most users learn the basics and then some advanced commands that suit their needs. Some users are constantly learning new commands to speed their editing. A nerdy few progress to writing their own totally new Emacs commands.

Giving Commands Arguments

Many Emacs commands take arguments, the way a procedure or function takes arguments in a programming language. Most com-

mands prompt you for their arguments: e.g., a command to read in a file will prompt you for the filename.

There's one kind of argument that's so commonly accepted that there's a special way to provide it: a numeric argument. Many commands will interpret a numeric argument as a request to repeat themselves that many times. For example, the `C-d` (`delete-char`) command, which normally deletes one character to the right of the cursor, will delete *N* characters if given a numeric argument of *N*. It works with `M-x` commands and self-inserting commands too: try giving a numeric argument to a printing character, like a hyphen.

To give a command a numeric argument of, say, 12, type `C-u 12` before typing the command. If you type very slowly, you'll see:

```
C-u 1 2-
```

in the Echo Area. Then type `C-d` and you'll have given `delete-char` an argument of 12. You can type any number of digits after `C-u`. A leading hyphen (`C-u - 1 2`) makes a negative argument; a lone hyphen (`C-u -`) is the same as an argument of -1 (which makes many commands "go backwards" in some sense). If you begin typing a numeric argument and change your mind, you can of course type `C-g` to abort it.

Because a numeric argument is given *before* you type the command, it's also called a *prefix argument*; see "Arguments" in the *Emacs* manual.

Since one often isn't interested in *precisely* how many times a command is repeated, there's a shorthand way to get numeric arguments of varying magnitudes. `C-u` by itself, without any subsequent digits, is equal to a numeric argument of 4. Another `C-u` multiplies that by 4 more, giving a numeric argument of 16. Another `C-u` multiplies that by 4 more, giving a numeric argument of 64, etc. So `C-u C-u C-u C-d` would delete the next 64 characters.

`C-u` can be used before any other command, and for this reason `C-u` is called the *universal argument*. But note that commands aren't required to interpret numeric arguments as specifying repetitions. It depends on what's appropriate: some commands ignore numeric arguments, some interpret them as Boolean (the presence of a numeric argument — any numeric argument — as opposed to its absence), etc. Read the documentation for a command before trying it.

Disabled Commands

Some commands that are especially confusing for novices are *disabled* by default. When a command is disabled, invoking it subjects you to a brief dialog, popping up a window displaying the documentation

for the command, and giving you four choices; for example:

```
You have typed C-x n n, invoking disabled command narrow-to-region.
It is disabled because new users often find it confusing.
Here's the first part of its description:

   Restrict editing in this buffer to the current region.
   The rest of the text becomes temporarily invisible and untouchable
   but is not deleted; if you save the buffer in a file, the invisible
   text is included in the file.  C-x n w makes all visible again.
   See also 'save-restriction'.

Do you want to use this command anyway?

You can now type
y   to try it and enable it (no questions if you use it again).
n   to cancel--don't try the command, and it remains disabled.
SPC to try the command just this once, but leave it disabled.
!   to try it, and enable all disabled commands for this session only.
```

If you invoked the command by accident, just hit `n`. If you're sure you know what you're doing, hit `y`. Otherwise, `SPC` is the way to go, until for any given command you're comfortable enough with it to say `y`.

In this book, I make occasional recommendations to un-disable certain commands I consider very useful; you can see them all in my recommended Initial Init File.

Felicity in Key Bindings

I define a *felicitous key binding* to be one that can be easily repeated, possibly even auto-repeated by your keyboard. The most felicitous binding is a single keystroke, like `C-f`; you can repeat it easily by just holding down Control and tapping away af `f`. Even *chorded* single keystrokes like `C-M-f` are maximally felicitous.

Any prefix binding is less so. A two-character prefix binding that uses the same modifier key in each case, such as `C-x C-t`, is not too bad, as you can just keep the modifier held down and quickly tap `x` and `t`. But when the modifiers differ, we have maximum infelicity.

Consider the horrible horizontal scrolling key-binding `C-x <` (`scroll-left`),[33] which is effectively `C-x S-,`. Repeatedly invoking this command while observing the change in the visible part of the text in the Window is like playing a particularly complex arpeggiated piano part: hold down Control, hit `x`, lift finger from `x` and lift finger from Control, hold down Shift, hit `<`, lift finger from Shift and from `<`, and finally repeat.

[33] See *The Horizontal Scroll Bar*.

Since any Emacs command can be bound to more than one keystroke, in some cases like this, I provide Init File snippets with additional more felicitous bindings, like my `S-C-<` for `scroll-left`, which can be easily tapped out or auto-repeated.

In most cases, the felicity of key bindings is a minor issue, but

for commands that you tend to repeat, like scrolling commands, Window-switching commands, and dragging commands, more felicitous bindings can make a big difference.

About Mouse Bindings

As mentioned, I don't use the mouse in Emacs at all (and barely at all in an external web browser, my only other GUI application), so I won't be devoting much space to it, except to say that Emacs fully supports it.

The mouse is a much more complex user interface device than the keyboard. Consider the traditional hand-held mouse (ignoring laptop touchpads for the moment). The minimal mouse has one button, which, like a key on a keyboard, can be pressed (or *clicked*) to generate an *event* that can be bound to an Emacs command. Also like a key-press, this button-click can be modified by any of the keyboard modifier keys, such as Shift, Control, Meta, and the like.

But the complexity of a single mouse click goes way beyond this. We need to potentially distinguish between a button-*press* and a button-*release*, a simple in-place click versus a *drag*, motion without clicking, and double- and triple-clicks (or even more).

But that's not all: many mice have more than one button: mice on Unix systems traditionally have three buttons, and two- and five-button mice are common. Unlike non-modifier keyboard keys, multiple mouse buttons can be *chorded*: that is, pressing or clicking two or more buttons simultaneously counts as a completely different button![34] Many mice have a *scroll wheel*, which acts as another, more complex button, which may also *tilt*. Laptop touchpads add more complexity. And the keyboard modifier keys can be mixed into all of this.

Emacs defines an abstraction of all this complexity, defines a set of default global mouse bindings, and of course allows you to modify or add mouse bindings yourself.[35]

All that said, I'll just summarize the most basic default global mouse bindings; you can get complete details in the manual.

- clicking button 1 moves Point to the location of the click
- dragging with button 1 selects text
- clicking button 2 moves Point and then pastes the contents of the system clipboard[36]
- clicking button 3 copies the text between Point and the clicked location to the kill ring

[34] Rob Pike's text editor Acme, from the Plan 9 operating system, is almost unusable without a 3-button mouse, since it relies so heavily on mouse chords.

[35] My personal configuration completely *disables* all mouse bindings when I'm using a laptop, because it's far too common for me to generate mouse events accidentally when the heel of my palm brushes against the touchpad, which drives me crazy.

[36] Under X on a Unix machine, this actually yanks the primary selection.

Files, Buffers and Windows in Brief

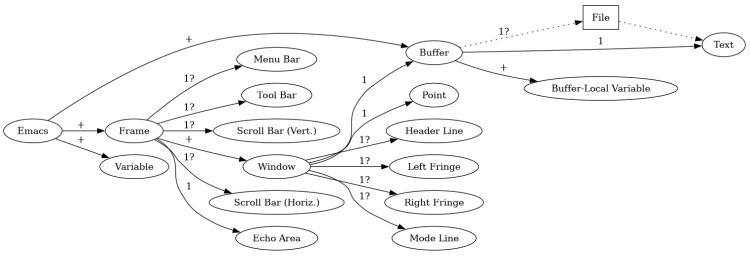


Figure 4: Emacs Data Structures

Legend:

+	One or more
1	Exactly one
1?	One or none

Emacs has three data structures (actually four) that are intimately related; you can't really grok Emacs without understanding them.

File A *file* is the actual file on disk. You are never directly editing the data in this file. Rather, you read a copy into Emacs to initialize a *Buffer*, edit the Buffer's copy, and write the contents of the Buffer back out to the file to save it. A file of course contains *text*: characters in some character set, say, Unicode[37].

[37] Emacs is also happy to edit non-text (binary) files, like images and executable files, and has special modes for this.

Buffer A *Buffer* is the internal data structure that holds the text you actually edit. Emacs can have any number of Buffers at any moment. Many Buffers, but by no means all, are associated with a file. Buffers have names; a Buffer that has been initialized from a file is almost always named for that file, and we say that the Buffer is *Visiting* the file. This means, in particular, that when you save the Buffer, it's saved to the proper file. At any given instant exactly one Buffer is selected or *current* (even if several are visible): this is the Buffer that your focused cursor is in, and this is where most of the commands you type take effect (including self-insert commands). Buffers can be deleted at will; deleting a Buffer in no way deletes any file on disk, and if you have any unsaved editing changes, Emacs won't let you delete the Buffer (unless you insist). See *Buffers* for details.

Window A Window is a view into a Buffer. You can split any Window, horizontally or vertically, into as many Windows as you like (or at least have room for), each viewing a different Buffer. It's also

possible to have several Windows viewing different portions of the *same* Buffer. The relationship between Buffers and Windows is transient: typically, many Buffers have no Window viewing them at any moment and in general, Buffers outnumber Windows by a large margin.

Windows can be created and deleted at will; deleting a Window in no way deletes the Buffer associated with the Window. Each Window has its own Mode Line, but there's still only the one Echo Area. See *Windows* for details.

Don't confuse Emacs Windows with windows on your desktop! Emacs had multiple Windows two years before Graphical User Interfaces were commercially available. Once GUI desktops became common and used the term "window" for their own purposes, Emacs added support for these "desktop windows", but needed to use a new name for them: *Frame*.

Frame A Frame is a "desktop window" that is treated as a separate entity under a windowing system like X. When Emacs starts up, it creates one Frame for you, but you can have as many as you like. Each Frame can hold several Emacs Windows, and, in fact, has it's own Echo Area (I lied above), but all Buffers are shared in common across all Frames. I won't be discussing Frames much, as I rarely want more than one. But see *Frames* for details.

Basic File Concepts and Commands

The most common things you do with files are load them and save them.

`C-x C-f` *(`find-file`)* This is the main command used to read a file into a Buffer for editing and is what the menu item File / Open File does. It's actually rather subtle. When you execute this command, it prompts you for the name of the file (with Completion). Then it checks to see if you're already editing that file in some Buffer; if you are, it simply switches to that Buffer and doesn't actually read in the file from disk again. If you're not, a new Buffer is created, named for the file, and initialized with the contents of the file. To create a brand new file, just type a nonexistent file name; you'll get an empty Buffer that will create a new file when saved[38]. In any case, the current Window is switched to view this Buffer.

`C-x C-s` *(`save-buffer`)* This is the main command used to save a file, or, more accurately, to write a copy of the current Buffer out

[38] But not before: if you visit a new, non-existent file, insert text into it, but then kill the buffer (after reassuring Emacs that you *want* to discard your edits), the file will *not* have been created,

to the disk, overwriting the Buffer's file, and handling backup versions.

`C-x s` *(`save-some-buffers`)* This command allows you to save all your Buffers that are visiting files and have modifications, querying you for each one and offering several options for each (save it, don't save it, peek at it first then maybe save it, just save all of them without asking further questions, etc).[39]

See *Files* for more information.

[39] Emacs does `save-some-buffers` implicitly when you exit, as well.

Basic Commands to Manipulate Buffers

The most common things you do with Buffers, which you can for now think of as opened files, are switch between them, list them (in case you've forgotten which ones you've opened), and occasionally clean them up. But to paraphrase Philidor, "The Buffers are the soul of Emacs" and in short order you'll be doing a lot more with them.

`C-x b` *(`switch-to-buffer`)* Prompts for a Buffer name (with completion) and switches the Buffer of the current Window to that Buffer. Doesn't change your Window configuration (if you had three Windows before, you still have three afterwards). This command will also create a new empty Buffer if you type a new name; this new Buffer will not be visiting any file, no matter what you name it (until you save it, at which point it will be visiting the just-created file).

`C-x C-b` *(`list-buffers`)* Pops up a new Window which lists all your Buffers, showing for each the name, state (modified or not), size in bytes, the Buffer's major mode, and the file the Buffer is visiting (if any). This is an *interactive Buffer*, meaning that, within it, you're in a special mode that allows you to manipulate Buffers: select them, delete them, save them, search a subset of them, etc.

`C-x k` *(`kill-buffer`)* Prompts for a Buffer name (with completion) and removes the entire data structure for that Buffer from Emacs. If the Buffer is modified *and* is visiting a file, you'll be given an opportunity to save it. Note that killing a Buffer in no way removes or deletes the associated file (nor does it delete the Window; that Window will simply start displaying some other Buffer). `kill-buffer` is happy to delete a modified non-file Buffer without any warning however, so don't keep important notes in Buffers like this (such as the `*scratch*` Buffer). (Emacs has better ways of note-taking anyway.)

C-x C-q (read-only-mode) Make a Buffer read-only (so that attempts to modify it are treated as errors), or make it read-write if it was read-only. If you open a file that you don't have permission to modify, Emacs sets the Buffer to read-only, to prevent you from wasting your time editing it when you won't be able to (directly) save it. This command lets you have your way with it.

See *Buffers* for more information.

Basic Commands to Manipulate Windows

Just like the windows on your desktop, the most common things you do with Emacs Windows are create them, delete them, resize them, switch between them (i.e., change the focus), and scroll around in them. Emacs manages its Windows in a *tiling* manner, like one of those tiling window managers that are all the rage these days.

See *Windows* for more information.

Create a New Window

To create a new Window, you have to pick an existing Window (there's always at least one!) and split it in two. You can split it vertically (which means you now have less vertical space in the original Window) or horizontally.

C-x 2 (split-window-below) Splits the current Window in two, vertically (into two Windows, one below the other). This creates a new Window, but not a new Buffer: the same Buffer will now be viewed in the two Windows. This allows you to view two distant parts of the same Buffer simultaneously, by moving around independently in the two Windows. Of course you can switch to a different Buffer in one of these two Windows with, say, `C-x b` (`switch-to-buffer`) or `C-x C-f` (`find-file`). Mnemonic: "`2` Windows where there was `1`".

C-x 3 (split-window-right) Splits the current Window in two, horizontally (into two Windows, side by side). This also creates only a new Window, and not a new Buffer: the same Buffer will now be viewed in the two Windows. Mnemonic: "slightly different from `C-x 2`".

Delete a Window

C-x 0 (delete-window) Deletes just the current Window, resizing the other Windows in the current Frame appropriately. This does *not*

delete the Buffer (nor file) associated with the Window. Mnemonic: "zero this Window".

`C-x 1` *(`delete-other-windows`)* Deletes all other Windows in the Frame except the current one, making one Window in the Frame. Does *not* delete the Buffers (or files) associated with the other Windows. Mnemonic: "show me just this 1 Window".

Resize Windows

Since Emacs tiles Windows, you can't resize just one Window[40]. If you want to make it bigger, you have to steal real estate from some other Window, and if you want to make it smaller, you have to donate real estate.

[40] Though you can have Emacs or your window manager resize the entire Frame.

I think the default Emacs key bindings for resizing Windows are very awkward; see "Change Window" in the *Emacs* manual. This is easily fixed with some custom bindings; I'll give the ones I've used for years later.

In graphical mode, you can use the mouse: just point the mouse at the Mode Line that's between the two Windows whose mutual sizes you want to adjust. Point anywhere in the mode line as long it's not on top of any text or icon, and then click and drag with the left mouse button.

Side-by-side Windows (as created by `C-x 3` (`split-window-right`)) don't have a Mode Line between them, of course, but there is a vertical dividing line that you can likewise use, with the mouse, for resizing.

Switch Windows

The simplest way to switch Windows is to cycle through all of them with `C-x o`, stopping at the one you wanted to get to. I rarely do it this way and will discuss better, less tedious methods later. In graphical mode, you can use the mouse to switch Windows: just click anywhere in the desired Window with the left mouse button.

`C-x o` *(`other-window`)* Switch to the other Window, making it the active Window. Repeated invocation of this command moves through all the Windows in the Frame, left to right and top to bottom, and then circles around again. Which Window is the "other window"? See *Switching Windows*.

Scroll Within a Window

Scrolling horizontally is only necessary if you have a combination of tall skinny Windows and long lines; we'll ignore that for now.

But it's very common for a file to have many more lines than will fit vertically in a Window.

You can of course scroll with the mouse and the scrollbar (or the scroll wheel) if you don't mind taking your hands off the keyboard.

C-v (scroll-up) The basic command to scroll forward (towards the end of the file) by one screenful. (Is this up or down? Depends on your point of view.) By default Emacs leaves you two lines of context from the previous screen. Mnemonic: "View more of the Buffer" or "The *V* points toward the text you want to see". `scroll-up` is also bound to the `<PageDown>` key[41].

M-v (scroll-down) Just like `C-v`, but scrolls backwards. Mnemonic: "`C-v` goes forward so `M-v` goes the other way". `scroll-down` is also bound to the `<PageUp>` key.

[41] This seems wrong — up is down, down is up: have we gone through the looking glass? — but it's just because the words describing scrolling are inherently ambiguous.

You can also directly scroll a Window other than the one you're in. This is just a shorthand for switching to the Window you want to scroll, scrolling it, and switching back to the Window you came from. If you have a lot of Windows in your Frame, that's exactly what you'll have to do, but for the common case of two Windows, we have a simple command:

C-M-v (scroll-other-window) Just like `C-v`, but scrolls the other Window. This works with more than two Windows, in which case the other Window is the Window that `C-x o` would switch to. You can give it a negative argument to make it scroll backwards.

There's more about scrolling to come.

Selecting Text: the Point, the Mark, and the Region

Selecting a range of text is fundamental to editing. It enables you to act upon the text: delete it, copy it, modify it, change how it's displayed (highlight or colorize it, change its font or size), investigate it (count its words or lines), search for other occurrences of it, focus on it (search or undo within it, narrow to it so that's all you can see), feed it to something outside of Emacs.

The Emacs term for a range of selected text is the *Region* ("Using Region" in the *Emacs* manual): it's simply the text in your Buffer between the *Point* and the *Mark*.

The Point

Point ("Point" in the *Emacs* manual) is the Emacs term for what we've been loosely calling your *cursor* up to now; the cursor always shows the position of Point in your Buffer. Point is where text is inserted when you type, and where most editing operations happen. When you "move" in a Buffer, you're simply adjusting the location of Point.

Point is really just a number: the offset, in characters, from the beginning of the Buffer, of the character after Point. You typically don't care about this number as such unless you're writing Elisp, but if you want to know the value of Point, `C-x =` (`what-cursor-position`) will report it in the echo area (along with some other interesting information[42]).

[42] `C-u C-x =` will report a *lot* of interesting info.

Point always identifies a location *between* two characters. By default, Emacs displays, in the current Window, a cursor at Point in the form of a solid box. The box seems to be *on top of* a character, but Point is *before* that character. (You could ask Emacs to instead display the cursor as a thin vertical line, which would make the position of point as *between* two characters easier to understand, but at the cost of being harder to spot.)

Every Window has a distinct Point which is always visible in that Window. This means that if you visit a file and split the Window into two, you can have Point in a different position in each Window, so you can look at distant parts of the file at the same time.

The Mark

The *Mark* ("Setting Mark" in the *Emacs* manual) is a sort of additional, invisible, Point. A Buffer can only have one Mark[43], and every Buffer's is distinct. However, unlike Point, there's no Mark in a Buffer until you set one (explicitly or implicitly).

[43] But see the Mark Ring.

The main purpose of the Mark is to determine one end of the Region, Point being the other.

You set the Mark (at the same location as Point) with a special command, `C-SPC` (`set-mark-command`); `C-@` is an old synonym. Then, as you move Point, the Mark stays where you set it and whatever is between the two forms the Region.

The Region

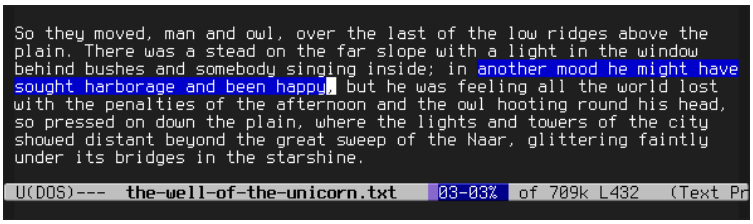


Figure 5: The Active Region (Mark at the beginning)

The *Region* is the text between Point and Mark. If the Mark exists in a Buffer, so does the Region (because Point always exists). The Region can be of any size: a few words, many paragraphs, the next 253 characters. If you set the Mark and don't move Point, the Region is of size zero. (Yes, an empty Region is useful.) If you set the Mark at the end of the Buffer, and move Point to the beginning of the Buffer, then the Region encompasses the entire Buffer.

In fact, the Region is the same regardless of whether Point comes first in the Buffer or Mark does; it makes no difference, just do what's convenient.

This scheme predates the commercial availability of the mouse, and provides a keyboard-driven equivalent of sweeping out text with the mouse. In fact, if you click mouse button 1 (usually the left button) at a position in the Buffer, and drag the mouse pointer in any direction, and then let go of the button, Emacs sets the Mark at the place where you clicked, and the Point at the place where you let go — another way to set the region.

When you explicitly set the Mark with `C-SPC` (or the mouse), the Mark is *activated*, and the Region is suddenly colored differently so you can visualize it (see Figure 5). If the color becomes distracting, a `C-g` will deactivate the Region, as will most commands that operate

on the Region after they're done with it (so the Active Region is typically transient: set it — color! — act on it — color gone).

But remember, the Region still exists (because there's a Mark) even if inactive and invisible: you can still use it[44]. If at any time you're not sure of its extent, `C-x C-x` (`exchange-point-and-mark`) will reactivate the Region (and hence colorize it); it also swaps Point and Mark, which is handy if you want to fine-tune the extent of the Region with additional motion commands, or if you want to get to, or just peek at, the other end (the Region might be big enough that you can't see both ends at the same time).

[44] Though a few commands will make a distinction between an active and an inactive region, to add utility.

Once you've got a Region, you can do stuff to it. What kind of stuff? Delete it; copy it; duplicate it; capitalize or otherwise change the case of it; search-and-replace or undo within it; narrow your view of the Buffer to it; do a web search for it; treat it as a rectangle; write it out to a different file; colorize it; comment it out, count the words, characters, and lines within it; pipe it through a shell command. There are hundreds, nay, thousands, of Emacs commands that operate on the Region, and you can readily make your own.

In a typical GUI editor like Microsoft Word or Google Docs, you spend much of your time sweeping out or selecting text with the mouse and then activating a menu or toolbar item; the Emacs equivalent is to set the Region and then execute a command with a keystroke. In Emacs, you can likewise use the mouse and a menu, but you can also do everything with the keyboard, and in addition to setting the Region by setting the Mark and explicitly moving, you can set it implicitly via textual object commands, search commands, and more.

So now you know how to define the Region: let's do stuff to it.

`C-w` (`kill-region`) Kills the Region. (You can yank it back elsewhere.) Other editors call this operation *cut*. Mnemonic: *wipe* the region.

`M-w` (`kill-ring-save`) Saves the Region without removing it from the Buffer (so you can yank a copy back elsewhere). Other editors call this operation *copy*. Mnemonic: a "bigger" wipe (which includes an immediate "paste").

`C-x C-i` (`indent-rigidly`) Rigidly indents (or dedents) the Region using the arrow keys; `C-u 12 C-x C-i` indents the region exactly `12` characters, without using the arrow keys.

`C-x C-l` (`downcase-region`) Convert the entire Region to lowercase. This command is disabled by default.

`C-x C-u` (`upcase-region`) Convert the entire Region to uppercase. This command is disabled by default.

M-q (fill-region) Fills, i.e., justifies with a ragged right margin, all the paragraphs within the Region; with a prefix argument, right justify the paragraphs.

There are hundreds more commands that act on the Region, and the Region is fundamental to the way cutting and pasting is done in Emacs.

Cutting, Copying, and Pasting

Cutting, copying, and pasting to and from the clipboard — the fundamental editing operations — in most applications exist as three keyboard shortcuts, known as *Control+x*, *Control+c* and *Control+v* respectively, called *CUA*[45].

[45] IBM codified this as its *Common User Access* (CUA) standard; in Mac OS, you use *Command+* instead of *Control+*.

Emacs, of course, uses different terminology and key bindings — how can it not, predating the CUA "standard" by close to ten years?

CUA Menu Item	Key	Mac OS	Emacs Command	Key
Cut	*Control+x*	*Command+x*	`kill-region`	`C-w`
Copy	*Control+c*	*Command+c*	`kill-ring-save`	`M-w`
Paste	*Control+v*	*Command+v*	`yank`	`C-y`
Select All	*Control+a*	*Command+a*	`mark-whole-buffer`	`C-x h`

Emacs calls cutting, "killing"; and it calls pasting, "yanking". So select your text (by setting the Region), and then use the Emacs keystrokes in the table above, and things will work mostly as you expect.

Aside from the keystrokes, this is directly analogous to the way cutting and pasting is done everywhere else. If you really can't face the idea of learning these four keystrokes, you can enable CUA Mode, which will let you use the keystrokes you're used to.

Now we're done with this chapter, right? Feel free to skip ahead to the next chapter to continue your Emacs exploration, but be sure to come back here later for a little more info.

Welcome back!

It's time for some tough love. Emacs cut-and-paste goes significantly beyond that of most applications, but, I have to admit, at the cost of a significant learning curve. The advanced features are probably the most complicated part of beginner-level Emacs knowledge. The reason is just that it's all very abstract and tenuous, and you have to picture invisible things in your head.

What are these advanced features?

1. Commands to precisely select (i.e. set the region around) a whole range of *textual objects*: words, symbols, lines, sentences, paragraphs, and more. We cover these in the next chapter. There are commands to directly select and kill (cut) these objects.

2. A history of previously killed and copied text. The Mac OS and Windows clipboards only hold one item—the last piece of text you killed or copied. Emacs remembers your 120 most recent items, and there's no limit—you can increase it if you like.[46]

[46] You need a third-party application from the App Store to embiggen the Mac OS clipboard. As of Windows 10, Microsoft users now have a clipboard history; it's not enabled by default: when enabled, the clipboard history supports up to 25 items.

Emacs calls its "clipboard" the *Kill Ring*, and it's an invisible (albeit inspectable) data structure that you normally have to picture in your mind's eye as you use and change it.

With the addition of one more command, new in version 28 of Emacs, your suite of cutting and pasting commands looks like this:

Action	Key	Emacs Command
Cut	`C-w`	`kill-region`
Copy	`M-w`	`kill-ring-save`
Paste	`C-y`	`yank`
Paste from History	`M-y`	`yank-pop`

`C-y` yanks ("pastes") your most recent kill (or copy), but you can get back any of your last 120 kills by instead using `M-y`. It presents all your kills using the Completion system: just choose the text you want to yank, as in Figure 6.

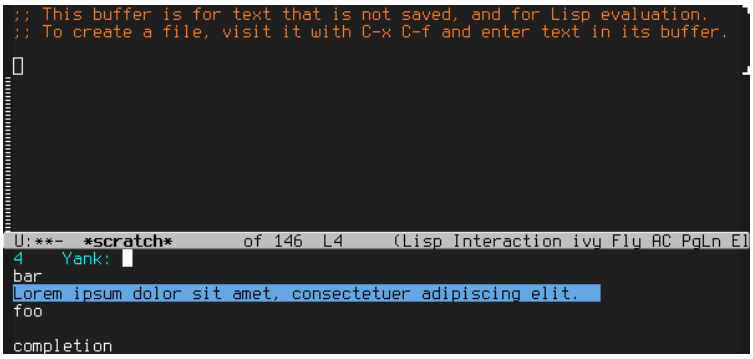


Figure 6: Yanking Back in Time

This function works best with an Incremental Narrowing Framework like Ivy or Selectrum (Ivy is shown in Figure 6).

Until you read *Yanking Older Kills*, you shouldn't invoke this command immediately after `C-y`: it will have a different effect. If you need to use `M-y` right after a `C-y`, just precede it with `C-g` (`keyboard-quit`).

The Kill Ring

When you kill the Region with `C-w`, Emacs adds the killed text to a data structure called the *Kill Ring*, which holds the last several kills. This allows you to get older kills back. When you yank with `C-y`, the most recent kill from the Kill Ring is inserted into the Buffer at Point; it's not removed or popped off the Kill Ring, so if you yank again, you get another copy.

The Kill Ring is really a linear list, and killing with `C-w` feels like pushing onto a stack; but the commands that deal with it actually treat it as a circular structure, so we call it a *ring*.

The Kill Ring is a *global* data structure, shared by all Buffers: this is so that you can use the Kill Ring to move text from one Buffer to another: kill some text in Buffer A, switch to Buffer B and yank it: you've moved the text.

What about copying text? Clearly, you can *copy* and paste by doing `C-w` to kill, *immediately* yank it back to where it was with `C-y`, and then move elsewhere and yank again (your text is still at the front because yanking doesn't pop the Kill Ring). That's `C-w C-y` (move somewhere) `C-y`.

`M-w` is a shortcut for `C-w C-y`, so we usually use that for copying: `M-w` (move somewhere) `C-y`.

Yanking Older Kills ("Clipboard History")

Here's how yanking older kills worked in olden times (before v28's new `M-y` (`yank-pop`) command). Unless you're a connoisseur of Emacs history (this all still works...), I suggest you skip ahead!

Suppose we kill the word "foo" in some Buffer. This pushes it onto the front of the Kill Ring (who knows what else is behind it):

```
foo  ...
↑
```

The arrow points to what `C-y` will yank, by default the latest kill. Then we do some more work, and kill the word "bar" somewhere else. Now the Kill Ring looks like this:

```
bar  foo  ...
↑
```

Now we want to paste the "foo" somewhere[47]. How do we get at it?

We yank with `C-y` and "bar" (what the arrow points to) is inserted. But now we immediately type `M-y` (`yank-pop`). When invoked immediately after `C-y`, it moves the yank-pointer back one step:

```
bar  foo  ...
     ↑
```

[47] You would probably just retype "foo" — but imagine larger chunks of text here: whole lines or paragraphs.

and *simultaneously* replaces the just-yanked "bar" at Point with "foo". If we immediately type `M-y` again, it would move the yank-pointer back one more step, and replace "foo" with whatever is next oldest in the Kill Ring.

You don't really need to picture the Kill Ring. When you want something from it, just type `C-y` and then if you think, "no, older" type `M-y`, and if you think, "no, older", type another `M-y` and so on.

The only trick here is that you have to type `M-y` *immediately* after a `C-y`, or after a `M-y`: if you do anything in between — moving, typing, popping up the calendar — `M-y` will do the wonderful new thing of offering up older kills for Completion; if your Emacs is older then v28, it will complain with "Previous command was not a yank".

If you actually type 60 `M-y`'s, you would then cycle around to the front of the Kill Ring again!

Suppose the Kill Ring looks like this:

echo delta charlie bravo alpha ...
↑

Let's look at the results of some yanks (each of these examples is an alternative to any of the others):

- `C-y` would yank "echo"
- instead, `C-y M-y` would yank "delta"
- or, `C-y M-y M-y` would yank "charlie"
- or, `C-y M-y M-y C-y` would yank "charliecharlie" (`C-y` always yanks from the pointer)

Note that `C-y` takes a numeric argument (positive or negative), so that `C-u 3 C-y` in our example is the same as `C-y M-y M-y`. `M-y` works the same way.

What if you type several `M-y`'s and decide you don't want what you end up with? Usually you just undo them, but note that this undoes the changes to your Buffer, but doesn't undo the motion of the yank pointer. If you do `C-y M-y M-y`, yielding "charlie", you can undo, yielding "delta". But your next `C-y` will yank "charlie" again, since that's where you left the yank pointer.

When you've got your yanked text (whether acquired by one `C-y` or a chain of `M-y`'s, or the new Completion-based `M-y`), the Mark is set for you at the beginning of the restored kill, to make it easy for you to jump there (with `C-x C-x` (`exchange-point-and-mark`); see also the Mark Ring) — remember that you may have just yanked back a very large chunk of text, so the beginning could be a long way away.

Undoing a Yank

I stole a function from the EmacsWiki that I call `undo-yank` (originally named `yank-pop-forwards`), that lets you reverse direction in the middle of a sequence of `M-y`'s, in case you overshoot; this actually moves the yank pointer, so you can think of it as an undo for yanks.

Init File

```
;; thanks to an anonymous EmacsWiki coder
(defun undo-yank (arg)
  "Undo the yank you just did.  Really, adjust just-yanked text
like \\[yank-pop] does, but in the opposite direction."
  (interactive "p")
  (yank-pop (- arg)))
(keymap-global-set "C-M-y" 'undo-yank)
```

I Can't Picture This!

> Ever feel that 'C-y M-y M-y M-y . . . ' is not a great way of trying to find that piece of text you know you killed a while back? — Colin Walters

Emacs's abstract approach to the Kill Ring (an invisible data structure with an invisible yank-pointer), which may seem a mite austere, is very fast and efficient once you get used to it. But you might occasionally prefer a sort of WYSIWYG alternative, that lets you browse the Kill Ring interactively: see its entire contents and search it too. The new functionality of `M-y` command does this for you; an alternative is Colin Walters' third party package `browse-kill-ring`.

Other Ways to Set the Region

So far, we've been talking about killing (or copying) *the Region*: as if you were always going to be sweeping out text, mouse-like (even if with the keyboard). But really, it's much more common to work in terms of *textual objects* — in other words, kill a word or a line or a paragraph without bothering to sweep out its boundaries. We'll discuss textual objects in detail in the next chapter.

Appending to a Kill

Since the Kill Ring is a sequence of kills, you might think to use it to accumulate several separate chunks of text that you want to yank back elsewhere. Kill the first piece of text, move to the next and kill *it*; repeat several times and you've now got everything you want, in several chunks at the front of the Kill Ring.

But when it comes time to yank all these chunks back, you'll have to do a bit of a dance with a combination of `C-y`'s and `M-y`'s in a somewhat surprising order (because the kills are accumulated on the Kill Ring *backwards*).

What you want to do instead is append to a single kill at the front of the Kill Ring, with `C-M-w` (`append-next-kill`). So you kill the first piece of text, move to the second, but now type `C-M-w` before killing it with `C-w`; this causes the second piece to be appended to the text of the front kill, instead of added as a new kill as usual. Think of `C-M-w C-w` as a single *append to the kill* command.

If the three pieces of text are "alpha", "beta", and "gamma", the process looks like:

- move to "alpha", set the Region, and `C-w`:

```
alpha  ...
↑
```

- move to "beta", set the Region, and `C-M-w C-w`:

```
alphabeta  ...
↑
```

- move to "gamma", set the Region, and `C-M-w C-w`:

```
alphabetagamma  ...
↑
```

Now you can move elsewhere, and with one `C-y`, you yank back "alphabetagamma".

Obviously, `C-M-w` works the same with `M-w`, if you want to leave the original text in place.

`C-M-w` is a pretty low-level tool; Emacs has better ways of approaching the task of accumulating scattered chunks of text that don't use the Kill Ring at all.

Appending to a Buffer

When you want to collect several chunks of text from various locations, the best way to do it is to append the chunks to a Buffer.

Move to the first piece of text you want to collect—let's say the word "alpha"—and set the Region, but don't bother to kill or copy; instead say `M-x append-to-buffer-with-newline`. You'll be prompted for a Buffer name which will collect all the pieces of text you're gathering; just make up any name you like! If you're collecting Greek letters, you could call the Buffer "greek" or "g". Your text will be

appended to your Buffer (which will be created as needed) with a newline added at the end.[48]

Now find your "beta". `M-x append-to-buffer-with-newline` again and use the same Buffer name. Repeat for "gamma" and as many other things you're looking to collect.

When you're done, go to the place you want to "yank" your collection, and say `M-x insert-buffer`: the entire contents of your accumulation Buffer is inserted at Point.

This scheme has several advantages over the Kill Ring for ambitious text rearrangement.

- You can do your collecting and appending over a span of hours (or even days).
- It allows you to use the Kill Ring as you like in between accumulations.
- You can freely use several different collection Buffers for different sorts of text, and intermix your accumulations.
- The accumulation Buffer is just a Buffer like any other, so you can switch to it at any point to fix it up, or save it to a file; you also aren't required to use `M-x insert-buffer` to get your text; you can kill or copy the text you've accumulated to extract what you've collected in any order or combination.

See *Mass Line Deletion* for another solution, and "Accumulating Text" in the *Emacs* manual for more information.

[48] There's also the command `M-x append-to-buffer`, which works exactly the same way, except it doesn't add a newline, so all your chunks will be mashed together.

The Clipboard

The Kill Ring is a data structure to which only Emacs has access. But every time you kill or copy text to the Kill Ring — with any of the many commands that do so, not just `C-w` and `M-w` — Emacs also copies that text to the *system clipboard*. This is the data structure that all your other non-Emacs applications paste from (with the CUA keystroke *Control+v*, probably). So this gives you a simple way passing text to them.

It also works in the other direction: if the contents of the system clipboard are newer than the Kill Ring — because you did a cut or copy in a non-Emacs application — then `C-y` instead inserts the clipboard text — not the first item in the Kill Ring.

There are several configuration variables to control exactly how Emacs and the clipboard[49] interoperate; see "Clipboard" in the *Emacs* manual.

[49] And, on Unix machines, the more complex X Selections mechanism.

CUA Mode

If you're a long-time Windows user and the *Control+x*, *Control+c* and *Control+v* keystrokes are so thoroughly wired into your fingers that you just *can't* get used to `C-w`, `M-w`, and `C-y`, don't give up hope. Just say `M-x cua-mode` and Emacs will let you use the commands you're used to. In order not to completely clobber the hundreds of key bindings on the `C-x` and `C-c` prefixes, the CUA bindings are only operative when the Region is active (colorized). There are several subtleties and extra features, so see "CUA Bindings" in the *Emacs* manual for the complete story.

If you like `cua-mode`, you can turn it on by default in your init file with this line of code:

```
(cua-mode +1)
```

Editing with Textual Objects

Editing in general consists of inserting text, either by typing it or acquiring it from some existing source; and then, over time, moving from one spot to another in order to make changes (i.e. transform it).

In Emacs, both moving around and making changes are done largely via *textual objects* — things like characters, words, lines, sentences, and such — and you can:

- move in terms of them, and by moving, optionally:
- select them, and after selecting them,
- copy them,
- kill them, or
- transform them.

For each such object, there is a motion command that moves forward over it and another that moves backward (you can also think of this as moving to the end and to the beginning). All these motion commands interpret numeric arguments as repetitions, so with an argument of *N*, you can move over *N* objects with one command.

But of course, if you simply set the mark before moving, then when you've moved, you've also *selected* text — that is, you've put the Region around whatever you've moved over. Having selected, you can now immediately copy or kill the text, or transform it.

Suppose Point is the `|` in this line — you're in the middle of the word "telecommunications" — and you want to kill that word:

```
the intermediary of some telecommu|nications program, where the
```

To do so, you can move to the beginning of the word, set the mark, move to the end, and kill: that's four keystrokes:

```
1  M-b    backward-word
2  C-SPC  set-mark-command
3  M-f    forward-word
4  C-w    kill-region
```

Besides being completely general (killing a sentence just requires you to substitute sentence-motion commands for the word-motion commands, for example) this technique means that all you need to learn to use textual objects are the motion commands. But most of the textual objects also have a special command that *marks*, i.e. *selects*, them, which saves you a keystroke, so we could also kill "telecommunications" with just:

```
1  M-b  backward-word
2  M-@  mark-word
3  C-w  kill-region
```

In addition, most of the objects also define a command to kill them, which can save you another keystroke:

```
1  M-b  backward-word
2  M-d  kill-word
```

Or if you happen to already be at the beginning of the word, it's just one keystroke:

```
1  M-d  kill-word
```

You can choose how much mental effort to put into learning these additional commands, knowing that you can always achieve your goal in the 4-step manner. But most expert Emacs users eventually learn all of these special commands: even micro-optimizations pay off for things you do frequently.

Shift Selection

If you execute any of the motion commands while also holding the Shift key, you can short-cut the selection process via Shift Selection. Consider `M-f` (`forward-word`). If you instead use `S-M-f`, the Mark is automatically set at Point, and *then* you move forward one word: so the word is automatically selected. `S-M-f` is essentially `C-SPC M-f`. In our example:

```
1  M-b    backward-word
2  C-SPC  set-mark-command
3  M-f    forward-word
4  C-w    kill-region
```

we can instead do:

```
1  M-b    backward-word
2  S-M-f  forward-word (shifted)
4  C-w    kill-region
```

The same thing is true for motion backwards, and for any of the other textual object motion commands. Just add the Shift.

And, if you type a shifted motion command, and immediately repeat it (while holding down the Shift key), the selection is enlarged until you finally issue a non-shifted-motion command. So if you say `S-M-f S-M-f S-M-f` you will have set the Region around three words.

You can mix different objects too: `S-M-f S-C-n S-C-f` is also legitimate.

Transposing and Dragging Objects

A special case is *transposing* (or *swapping*) two objects: that is, put Point between two objects (say, sentences) and swap them — the left hand sentence is now the right hand sentence and vice versa. One single command replaces a more complicated pattern of killing, moving, and yanking.

For example, here in line 0 Point (`|`) is between "one" and "two". If we `transpose-words` with `M-t`, we get the result in line 1:

```
0 one | two three four five
1 two one | three four five
2 two three one | four five
```

Note that Point has moved forward, or if you prefer, it remains after "one". This means that another `M-t` will result in line 2. So several transpose commands in a row can be chained together. You might think of this as *dragging* "one" to the right.

Most of the transpose commands react to a numeric argument of *N* by transposing the object to the left of Point with the one *N* objects to the right. This means that an argument of `1` is the same as no argument (on line 0 above, the word "two" is one word away from the left-hand word "one").

But if we say `C-u 2 M-t`, we get this result, because "three" is two words to the right of "one":

```
0 one | two three four five
1 two three | one four five
```

Personally I think it's easier to chain several transpose commands to achieve the equivalent effect, but your brain may work differently.

A negative argument transposes in the opposite direction (backwards, rather than forwards). In addition, a numeric argument of `0` (which would otherwise not do anything!) is interpreted specially: it swaps the object containing or after Mark with the object containing or after Point, no matter how far apart they are! This is a long-distance transposition, with no chaining or counting required. Here

in line 0 ^ indicates Mark (in "one"), and | Point (in "eleven"); we say `C-u 0 M-t`:

```
0 ^one two three four five six seven eight nine ten ele|ven twelve thirteen
1 ele|ven two three four five six seven eight nine ten ^one twelve thirteen
```

(Frankly I've never internalized this and always just Kill, move, and Yank in this use case.)

The exact definition of what makes up a given textual object is often customizable and may vary slightly from mode to mode. This is useful because it means that you can use the same motion commands and yet have them automatically customized for different types of text.

Here's the complete list of standard Emacs textual objects, with their backward- and forward-motion, marking, killing, and transposing key bindings:

Object	Backward	Forward	Mark	Kill	Transpose
Character	`C-b`, ←	`C-f`, →		`C-d`	`C-t`
Word	`M-b`	`M-f`	`M-@`	`M-d`	`M-t`
Horizontal Line	`C-a`	`C-e`		`C-k`	
Vertical Line	`C-p`, ↑	`C-n`, ↓			`C-x C-t`
Sentence	`M-a`	`M-e`	`M-x ...`	`M-k`	`M-x ...`
Paragraph	`M-{`	`M-}`	`M-h`	`M-h C-w`	`M-x ...`
Sexp	`C-M-b`	`C-M-f`	`C-M-@`	`C-M-k`	`C-M-t`
Defun	`C-M-a`	`C-M-e`	`C-M-h`	`C-M-h C-w`	
Page	`C-x [`	`C-x ]`	`C-x C-p`	`C-x C-p C-w`	
Buffer	`M-<`	`M->`	`C-x h`	`C-x h C-w`	

N.B.: in these charts, `M-x ...` means that the obvious command exists but isn't, by default, bound to a key — that is, `M-x mark-end-of-sentence`, `M-x transpose-sentences`, and `M-x transpose-paragraphs`.

Characters, Words, and Lines

Object	Backward	Forward	Mark	Kill	Transpose
Character	`C-b`, ←	`C-f`, →		`C-d`	`C-t`
Word	`M-b`	`M-f`	`M-@`	`M-d`	`M-t`
Horizontal Line	`C-a`	`C-e`		`C-k`	
Vertical Line	`C-p`, ↑	`C-n`, ↓			`C-x C-t`

Characters

Object	Backward	Forward	Mark	Delete (left, right)	Transpose
Character	`C-b`, ←	`C-f`, →		`DEL`, `C-d`	`C-t`

The character is the smallest, the atomic, textual object.

`C-b` (`backward-char`) Moves backward (to the left) over a character. This is mostly the same thing that the left-arrow (`<left>` (`left-char`)) does (but there are subtle differences in the context of bi-directional text).

`C-f` (`forward-char`) Moves forward (to the right) over a character. Same deal with right-arrow (`<right>` (`right-char`)).

The *f* for *forward* and *b* for *backward* mnemonic will recur.

`DEL` (`delete-backward-char`) Deletes the character to the left of Point; note that this is not a *Kill* and the deleted character doesn't go on the Kill Ring (because at one keystroke per character, it's quicker to retype it than to kill and yank it).

`C-d` (`delete-char`) Deletes the character to the right of Point; also not a Kill.

`C-t` (`transpose-chars`) Swap the characters around Point; at the very end of the line, swap the two previous characters.

Words

Object	Backward	Forward	Mark	Kill (left, right)	Transpose
Word	`M-b`	`M-f`	`M-@`	`M-DEL`, `M-d`	`M-t`

`M-f` (`forward-word`) Moves forward over a word.

`M-b` (`backward-word`) Moves backward over a word.

Note the f/b mnemonic. Also, as another mnemonic, note that M-f is like a "bigger" version of C-f.

`M-@` (`mark-word`) Sets the Mark at the end of the current word; immediately repeating this command moves the Mark to the end of the next word, enlarging the Region by one word (this is generally the way all marking commands work).

`M-d` (`kill-word`) Kills text forward from Point to the end of the word.

`M-DEL` (`backward-kill-word`) Kills text backward to the beginning of the word.

`M-t` (`transpose-words`) Swap the words around Point.

Lines

Object	Backward	Forward	Mark	Kill	Transpose
Horizontal Line	`C-a`	`C-e`		`C-k`	
Vertical Line	`C-p`, ↑	`C-n`, ↓			`C-x C-t`

Lines can be considered vertically or horizontally. Horizontal first.

`C-a` *(`move-beginning-of-line`)* Moves to the beginning of the current line.

`C-e` *(`move-end-of-line`)* Moves to the end of the current line.

A for the beginning of the alphabet, E for "end".

Strangely, there's no command to set the region around the entire current line (though it's very easy to write one!).

`C-k` *(`kill-line`)* Kills from Point to the end of the current line, not including the newline unless the line is blank. Thus, if you're at the beginning of a non-blank line it takes two C-k's to kill the whole line and close up the whitespace.

`C-u 0 C-k` *(`kill-line`)* Kills to the beginning of the current line, not including the newline.

Now let's consider lines vertically.

`C-p` *(`previous-line`)* Moves up to the previous line; also on ↑ (`<up>`).

`C-n` *(`next-line`)* Moves down to the next line; also on ↓ (`<down>`).

`C-x C-t` *(`transpose-lines`)* Swap the line containing Point and the previous line, leaving Point after both (allowing chaining).

When moving vertically by lines, the cursor tries to stay in the same column, but if the target line is too short, the cursor will be at the end of the line instead: Emacs doesn't automatically insert spaces at the ends of lines (end of line is unambiguous)[50].

[50] Except in certain special modes.

It doesn't seem too intuitive to kill lines vertically by analogy with `C-n` and `C-p`; I know of no such commands.

Prose Objects: Sentences and Paragraphs

Object	Backward	Forward	Mark	Kill	Transpose
Sentence	`M-a`	`M-e`	`M-x ...`	`M-k`	`M-x ...`
Paragraph	`M-{`	`M-}`	`M-h`	`M-h C-w`	`M-x ...`

Sentences

When you're editing prose, motion by sentences and paragraphs is very convenient. Note that, by default, for the purposes of motion, sentences need to end with two spaces after their terminal punctuation (period, exclamation point, or question mark). This has become something of a *cause célèbre* lately, but don't worry, you can change sentence-ending to only require one space by Customizing `sentence-end-double-space`.

`M-a` *(`backward-sentence`)* Moves to the beginning of the current sentence.

`M-e` *(`forward-sentence`)* Moves to the end of the current sentence.

Note the mnemonic relationship between `C-a` / `M-a` and `C-e` / `M-e`. Again the Meta version is for a "bigger" object.

`M-x mark-end-of-sentence` Sets Mark at the end of the current sentence; this command doesn't have a default key binding (but you could give it one).

`M-k` *(`kill-sentence`)* Kill the text from Point to the end of the sentence.

`C-u -1 M-k` *(`kill-sentence`)* Kill the text from Point to the beginning of the sentence.

Paragraphs

You can similarly move by paragraphs — but what is a paragraph exactly? It depends on the Major Mode and you can tweak the definition yourself[51], but most commonly, paragraphs are delimited by blank lines.

[51] `M-x customize-group RET paragraphs`.

`M-{` *(`backward-paragraph`)* Move to the beginning of the current paragraph.

`M-}` *(`forward-paragraph`)* Move to the end of the current paragraph.

`M-h` *(`mark-paragraph`)* Sets the Region around the *entire* current paragraph; unlike the marking commands for smaller objects, in addition to setting the Mark at the end of the object, this one also moves Point to the beginning (this turns out to be much more useful for large objects).

`M-x kill-paragraph` Kill the text from Point to the end of the paragraph.

Larger Objects: Pages and Buffers

Object	Backward	Forward	Mark	Kill	Transpose
Page	`C-x [`	`C-x ]`	`C-x C-p`	`C-x C-p C-w`	
Buffer	`M-<`	`M->`	`C-x h`	`C-x h C-w`	

Pages are separated by *form feed* characters (`C-l` — that's L, not the digit 1), just as lines are separated by newline characters. This used to be a common concept back when Emacs was young; when printing, you had to manually indicate where a page break should occur, causing the printer to skip to the top of the next page (or "form"), and to do this you would insert a form feed character into your text.

Since form feeds count as whitespace in most programming and markup languages, pages are still a useful idea, and Emacs has several commands that do things in terms of them. You can insert a form feed into your file by typing `C-q C-l` (see Quoted Insert).

So while it's rare now to use a form feed to actually force a new page when printing[52], it's handy to be able to separate a large file into "pages" which are really just bigger sections than paragraphs. A typical organization in a file of source code is to precede each section header comment with a form feed, and then you can navigate by these logical sections via `C-x [` and `C-x ]`.

[52] Because now we tend to print formatted documents (e.g., PDFs) rather than plain text files.

Here's what it looks like in a file of my Emacs Lisp source code (Elisp comments start with one or more semicolons, and a form feed character displays as `^L`):

```
^L
;;; parsing and unparsing
```

That `^L` is *not* two characters, as you can clearly see if you move your cursor across it one character at a time: it just looks like it.

`C-x [` (`backward-page`) Moves to the beginning of the current page.

`C-x ]` (`forward-page`) Moves to the end of the current page.

`C-x C-p` (`mark-page`) Sets the Region around the *entire* current page; unlike most marking commands, in addition to setting the Mark at the end of the object, this one also moves Point to the beginning.

Finally, it's useful to be able to jump directly to the beginning or the end of the buffer without having to scroll.

`M-<` (`beginning-of-buffer`) Moves to the beginning of the buffer.

`M->` (`end-of-buffer`) Moves to the end of the buffer.

Mnemonic: the beginning of the buffer is a location that's less-than any other location, and vice versa.

`C-x h` *(`mark-whole-buffer`)* Move Point to the beginning of the buffer and set Mark at the end of the buffer.

`M-x mark-beginning-of-buffer` Set Mark at the beginning of the buffer, without moving Point,

`M-x mark-end-of-buffer` Set Mark at the end of the buffer, without moving Point.

Code Objects: Balanced Parentheses and Function Definitions

Object	Backward	Forward	Mark	Kill	Transpose
Sexp	`C-M-b`	`C-M-f`	`C-M-@`	`C-M-k`	`C-M-t`
Defun	`C-M-a`	`C-M-e`	`C-M-h`	`C-M-h C-w`	

An *S-expression*[53] ("sexp" for short) is the name, in Lisp, for *atoms* (symbols, numbers, and quoted strings) and the balanced parentheses that enclose them, recursively. In Emacs, this useful notion is available everywhere; it's especially useful for editing programming languages, but even in prose it's very useful to be able to move over, copy, or kill a parenthesized phrase. The characters that Emacs recognizes as parens are usually regular parentheses (aka round brackets), square brackets, and braces (aka curly brackets), but it depends on the Major Mode (for some languages, angle brackets (i.e. < and >) may act as parens too).

[53] *S-expression* stands for "symbolic expression".

But sexps are more than just balanced parens. A *symbol* (roughly, a *word*) that doesn't contain any parens also counts as a sexp, as does a number. In most programming language modes, quoted strings are sexps (using either single or double quotes, depending on the syntax of the language). A sexp is any of those, or a parenthesized sequence of them, recursively.

These commands may seem confusing at first, but for editing most programming languages they're fantastic. Not only do they move you around quickly and accurately, but they help spot syntax errors while you're editing, because they'll beep at you if your parens or quotes are unbalanced.

`C-M-b` *(`backward-sexp`)* Moves backward over the next sexp. If your cursor is just to the right of an opening paren, `C-M-b` will beep, because there's no sexp to the left to move over: you have to move up.

`C-M-f` *(`forward-sexp`)* Moves forward over the next sexp. Same error if your cursor is just to the left of a closing paren.

Here's an example of linear movement via sexps. The location of Point is shown by `|`, and we move forward with `C-M-f` each time. After three `C-M-f`'s Point is after "Emacs" in line `3`, because each of the first three words count as symbols and thus are sexps. But the next `C-M-f` leaps over the entire parenthesized expression in line `4`.

```
0. |In  1976,  Emacs  (in its original TECO form)  was invented.
1.  In| 1976,  Emacs  (in its original TECO form)  was invented.
2.  In  1976|, Emacs  (in its original TECO form)  was invented.
3.  In  1976,  Emacs| (in its original TECO form)  was invented.
4.  In  1976,  Emacs  (in its original TECO form)| was invented.
```

`C-M-u` (`backward-up-list`) Move backward up one level of parens. In other words, move to the opening paren of the parens containing the cursor, skipping over balanced sexps.

`C-M-d` (`down-list`) Move down one level of parens. In other words, move to the inside of the next opening paren, skipping over intervening sexps.

Let's move up in nested parentheses with `C-M-u`. On line `0`, Point is in front of the word "Lisp". We type `C-M-u` and on line `1`, Point is now in front of the nested parentheses. One more `C-M-u` and Point moves in front of the leftmost paren.

```
0. (in its original TECO form  (which preceded the |Lisp implementation))
1. (in its original TECO form |(which preceded the  Lisp implementation))
2. |(in its original TECO form (which preceded the  Lisp implementation))
```

Nested parentheticals may be poor prose style, but they're extremely common in source code in almost any programming language.

Now let's move down with `C-M-d`. On line `0`, Point is on the return type of this C function definition; on line `1`, after `C-M-d`, Point is inside the formal parameter list:

```
0. |void synctex_updater_free( synctex_updater_t updater) {
1.  void synctex_updater_free(|synctex_updater_t updater) {
```

`C-M-@` (`mark-sexp`) Set Mark at the end of this sexp.

`C-M-k` (`kill-sexp`) Kills the sexp after Point.

Since function defintions are such an important unit of text in programming languages, whether they're called defuns, subroutines, procedures, procs, or whatever, they also count as textual objects. Like the sexp commands, these commands work appropriately in most programming language modes. Emacs calls this generic notion of function or procedure *defun*, again after Lisp.

`C-M-a` *(`move-beginning-of-defun`)* Move to the beginning of the current function definition.

`C-M-e` *(`end-of-defun`)* Move to the end of the current function definition.

`C-M-h` *(`mark-defun`)* Sets the Mark at the end of the current defun.

Note the mnemonic analogy with lines and sentences.

Extending Kills

If you kill several times in a row, with any combination of kill commands, but *without any non-kill commands in between*, these kills are appended together in one entry on the Kill Ring — there's no need to precede the kills with `C-M-w` (`append-next-kill`). For example you can kill the next six words as a unit with `M-d M-d M-d M-d M-d M-d`, move elsewhere and yank back all six (with their intervening whitespace) with one `C-y`. `C-u 6 M-d` would be equivalent. You can kill a block of lines with a sequence of several `C-k`'s, or you could kill the next sentence and the following two words with `M-k C-u 2 M-d` (note that the numeric argument `C-u 2` doesn't break up the sequence of kills, because `C-u 2` is *part of* the following `M-d` command).

Adjusting the Region

After setting the Region around one or more textual objects, whether by setting the Mark and moving, or Shift Selection, or by object-specific mark commands, you can fine-tune the Region by lengthening or shortening it at either end with any other motion commands — perhaps you selected a paragraph with `M-h` but you don't want the blank line at the front of it, or selected a sentence and want to add the two words at the beginning of the following sentence. Just move Point in any manner. If you want to adjust the *other* end, where Mark is, use `C-x C-x` (`exchange-point-and-mark`): now Point is where the Mark was and you can adjust that end.

Other Ways to Move Around

The textual object motion commands covered in the last chapter are probably the most important means of motion in Emacs. But there are several other ways to move around.

Move by Searching

You can exploit your knowledge of the contents of your text by using Emacs's many search capabilities to move around. If you want move to where you were discussing Ursula K. Le Guin, just search for her name.

Follow a Breadcrumb Trail (The Mark Ring)

We learned in *Selecting Text* that there's only one Mark in any Buffer. This is strictly true, but there's an additional data structure in each Buffer called the Mark Ring (see Info) that holds a history of previous Mark locations[54].

Whenever you set the Region, whether with `C-SPC` (`set-mark-command`) or a mouse selection, or implicitly with textual object mark commands (like `M-h` (`mark-paragraph`)), the Mark's current location is pushed onto the Mark Ring. The Mark is also set for you automatically at places where you've done "significant" things, like changing text, moving a long way away in one big jump (there being many ways to do this), the spot where you issued a search command, and the like[55], and these locations also go onto the Mark Ring.

Thus a breadcrumb trail of Marks is left for you to find your way back, Theseus-like, to where you've been, and provides a quick way to get back to these previous locations. The way to jump back to the previous Mark location is to give `C-SPC` (`set-mark-command`) an argument, so `C-u C-SPC`. It also rotates the Mark Ring, so that a repeated, uninterrupted sequence of `C-u C-SPC` commands will take you back in time through your previous Mark locations. The Mark Ring is a circular structure, so when you hit the end, you'll

[54] By default, the last 16 locations; you can change this value by Customizing `mark-ring-max`.

[55] You may notice the message "Mark set" or "Mark saved where search started" in the Echo Area when this "convenience Mark" is set automatically.

circle round to the most recent Mark location again. You'll notice the analogies to the operation of the Kill Ring.

It's a common idiom to set the Mark explicitly as a breadcrumb to jump back to, rather than as part of selecting some text. If you set the Mark, which activates the Region, and immediately set it again in the same spot, the Region is deactivated; this is nice for using the Mark to record your position — you're not really setting the Region, so why be distracted by the color of the active region? So remember `C-SPC C-SPC` as the breadcrumb-dropping command.

The Global Mark Ring

In addition to each Buffer's specific Mark Ring, there's a also a *Global* Mark Ring: this records a history of your locations in previous *Buffers*. So if you want to jump to the last place you were in the previous Buffer you were in, just use `C-x C-SPC` (`pop-global-mark`). The setting of these global marks is automatic: whenever you switch Buffers, Emacs pushes the Buffer you just left (and your location there) onto the Global Mark Ring. You can cycle through this ring, too.

Move Via Your History of Changes

Perhaps the most surprising way of moving is by Undoing; if you recently made a change to your text (possibly just by adding some more) and then moved elsewhere, it's pretty common to want to go back to where you made that change, and the easiest way to get there is to just Undo it, because wherever you may be now, an Undo pops you right back to the last change *in that Buffer*. You can use this trick even if you don't *want* to Undo your change — because you can instantly restore it by a Redo.

Obviously this trick gets much trickier if you want to move back to where you were, say, three changes ago: three Undos gets you to the right spot, but assuming you *liked* your changes, if you Redo them you're now back where you came from! The third-party packages `goto-last-change` and `goto-chg` solve the problem by going to the Undo locations without actually Undoing!

Mode-specific Motion

Various Major Modes may implement special ways of moving. Perhaps the most obvious is moving by *identifiers* (names) in programming language modes: you can move from a use of a function or variable to the definition, for example, or move through all the uses

of an identifier. This typically works across all the files in a defined project. Some languages have a bespoke way of handling this via the *language server protocol* (LSP)[56], but Emacs also supports various language-agnostic approaches, such as the Xref subsystem.

[56] I program in OCaml and use an LSP called Merlin for this.

Move by Scrolling

Sometimes, rather than moving pointedly to get to a precise location, you just want to scroll through your text to get an overview and stop at the spot that catches your fancy; scrolling is covered in the chapter on Windows.

Goto Commands

Most of the textual-object motion commands can be thought of as moving *relatively*: when you move forward by one word (sentence, paragraph, . . .) you're moving relative to the location of Point.

But occasionally it's useful to move to an *absolute* position (though much less often than one might think). The most common type of absolute motion is to move to a specific line by its line number. For example, according to `M-x what-line`, this line as I'm writing it is line 1,497. If I move elsewhere, I can come right back here by jumping to line 1,497!

Of course, since I'm editing, in a few minutes that line probably isn't line 1,497 anymore, and I probably won't remember that number for more than a few seconds, and anyway, if I wanted to come back here why don't I just use the Mark Ring or search?

I think most people who use line numbers as motion targets have line numbers turned on. Emacs doesn't display line numbers by de-

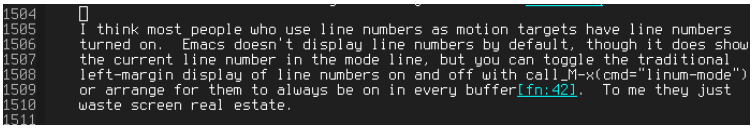


Figure 7: `display-line-numbers-mode` in action.

fault, though it does show the current line number in the mode line, but you can toggle the traditional left-margin display of line numbers on and off with `M-x display-line-numbers-mode`, or arrange for them to always be on in every Buffer[57]. To me they just waste screen real estate.

[57] Put `(global-display-line-numbers-mode)` in your init file.

But what if you're compiling a program in your terminal and it reports a syntax error on line 563? Well, you should be compiling that program in Emacs with `M-x compile`, and then you can jump to that error with a keystroke, with no need to type any line number; see *Compiling Code*.

However, it's true that you do occasionally get a line number foisted upon you in an unpredictable manner — say, from a stack trace when a program blows up, or from some log file. When you do, `M-g g` (`goto-line`) will prompt you for the number and jump there.

Much more rarely, you'll have a byte (character) offset from the beginning of some file; `M-g c` (`goto-char`) will take you there.

Finally, `M-g TAB` (`move-to-column`) is what you need for absolute positioning on the other axis: it moves to the given character offset from the left margin. There are lots of subtleties to this command — like, how do you count tab characters in the line, or multibyte (say, Unicode) characters? — but hopefully you'll never need it; I'd never used it before I had to write this paragraph! See the documentation for details.

Variables and Symbols

Usually the programming language in which a program is implemented is only of incidental interest to the user of the program. But all Emacs users know that it's implemented in Emacs Lisp, because the Lisp interpreter is always there, running Emacs and interacting with you to a degree that's unheard of in most programs.

One of the most important parts of the running Lisp interpreter is the collection of *symbols* that it contains: 43,057 at startup. A symbol — which is a name like `what-line` or `compile` or `kill-paragraph` — can hold a Command, in which case the symbol serves as the *name* of the Command[58], which you can use to execute the Command via `M-x` (`execute-extended-command`) or by which it can be attached to a keystroke via a key binding.

[58] Or a function.

A symbol can also be a *variable*—initially Emacs has 15,121 of them— and have a *value*. We say the value is *bound* to the variable. Most of these variables are used only by programmers in the implementation of the functions they write for you to use, but a subset of them—2,969—are *Customizable Variables* (a.k.a. *User Options*), which you can use to configure Emacs to your liking.

In this chapter we'll be talking mostly about User Options. They're fundamentally the same as plain old variables, but distinguished by being variables that you're *expected* to want to customize, and they have additional features to assist in this. But you can customize almost any variable if you want to, and some lazy Elisp programmers[59] simply might not bother to mark their variables as customizable. So I'll generally just use the term "variable" here.

[59] Like me until very recently, he said, shame-facedly.

What Are These Variables For?

Emacs is famously malleable and customizable: you can make it work and look exactly the way you want, and this is mostly achieved through variables. Do you not like the red color of the squiggles under your spelling errors? That color[60] is specified in the variable `flyspell-incorrect`, so you can change it.

[60] More accurately, that *face*...

Do you wish Emacs wouldn't beep at you when an error occurs?

The `visible-bell` variable lets you change that.

Throughout this book, I make some recommendations for tweaks to some variables, and give examples of others that you might want to change.

Types of Variable Values

A variable can hold any kind of Lisp value, and there are several types: truth values (corresponding to true / false or on / off: called *Booleans* by programmers), numbers, text (called *strings* by programmers), functions, and, perhaps most importantly, *lists*, which are sequences or collections of values of any types[61]. Also, and I don't want to blow your mind here, but a variable (which is a symbol, you'll recall) can also hold... *a symbol*.

[61] I'm simplifying here: Emacs Lisp has more types than these, and also makes some subtle distinctions that I'm glossing over.

Let's look at some examples of real Emacs variables and the (typical) types of values they hold.

Table 2: Examples of variables

Variable Name	Default Value	Type
`visible-bell`	`t`	Boolean
`delete-by-moving-to-trash`	`nil`	Boolean
`kill-ring-max`	`120`	number
`report-emacs-bug-address`	`"bug-gnu-emacs@gnu.org"`	string
`tool-bar-position`	`top`	symbol
`split-window-preferred-function`	`split-window-sensibly`	function
`image-types`	`(svg png gif tiff jpeg xpm xbm pbm)`	list

In Table **??**, we see that `visible-bell` is *on* (because `t` is the Elisp Boolean true value) while `delete-by-moving-to-trash` is *off* (because `nil` is the Boolean false value).

`kill-ring-max` determines the size of the Kill Ring.

`report-emacs-bug-address` is the email address for Emacs bug reports such as those generated by `report-emacs-bug`, and as such must be a string.

`tool-bar-position` specifies where the tool bar should be displayed, and must be one of the four symbols `top`, `bottom`, `left`, or `right`.[62]

[62] These are pure symbols, not variables, simply because they only need to exist as names and don't actually hold values.

`split-window-preferred-function` is a variable that holds a *function* that is actually called to split a window; `split-window-sensibly` is a symbol that names a function suitable for this purpose. Variables that hold a function are typically set to the symbol that names the function.

Finally, `image-types` is a list—of symbols, in this case, but Elisp lists can hold any types or combination of types (including nested lists).

Inspecting Variables

You can take a look at the current value of *any* Emacs variable at any time. The usual way is to use the Help facility via `C-h v` (`describe-variable`) or the more ecumenical `C-h o` (`describe-symbol`); see *Help for a Variable* for details.

Changing the Value of a Variable

As the name implies, you can also change the value that's bound to a variable. There are three *times* at which you might do this:

1. when Emacs starts up, via your Init File or the Customize Facility;
2. explicitly and interactively, while you are using Emacs;
3. whenever you visit a given file.

For cases 1 and 2, it's best to use Customize, because it provides documentation about how the variable works, guides you though the possibilities, prevents you from making common mistakes, and allows you to revert your changes or save them for future sessions. It's equally good for making settings for your startup configuration, for setting a value just for this session, or just to try out a new value for a while. You'll know you can use Customize when `C-h v` says, "You can customize this variable."

Note, however, that Customize only works for User Options. If you want to change a variable that hasn't been defined as such, you'll have to learn a little about Elisp.

Buffer-Local Variables

Variables can have different values in different buffers. For example, you might want to indent lines differently when you're writing a Python program than when you're writing prose. We call these *buffer-local* variables. They start out with a *default value*, but if you change the value of such a variable, the change only applies in the current buffer.[63]

[63] There's a way to change the default value too, but only via Elisp.

You can't change the local value of a buffer-local variable with Customize; you either do it via Elisp in your Init File (if you want the change in every Emacs session; see *Hooks* below), or else you use `M-x set-variable` to do it just for now, in the current buffer.

To set a variable with `set-variable`, you need to know the type of value the variable expects; that means you need to read its documentation with `C-h v`. You also need to know enough about Elisp to understand the *syntax* of the different types. There's a difference

between the number 256 and a string containing the three digits 2, 5, and 6.

If you say `M-x set-variable`, Emacs will prompt you for the name of a variable. You might enter:[64]

```
Set variable: report-emacs-bug-address
```

The next prompt would be:[65]

```
Set report-emacs-bug-address globally to value:
```

According to the documentation, this value needs to be a string; if you were to enter:

```
Set report-emacs-bug-address globally to value: myself@example.com
```

you would get a *type error*:

```
user-error: Value ‘myself@example.com’ does not match type string of report-emacs-bug-address
```

Table 3 provides a cheat-sheet for entering values of the major data types in the correct syntax; see "Init Syntax" in the *Emacs* manual for details, and also for how to set variables in your Init File. But remember, prefer `M-x customize-variable` whenever possible.

Type	Example	Another Example
Boolean (true or on)	`t`	
Boolean (false or off)	`nil`	
number	`256`	`1`
string	`"256"`	`"myself@example.com"`
symbol	`flyspell-incorrect`	`top`
function (same as symbol)	`find-file`	`set-variable`
list	`(1 4 12)`	`("/tmp")`

Table 3: Elisp Data Type Syntax

The syntax of Booleans is very simple: the true value is spelled `t` and the false value, `nil`.[66] I could give you other examples of the true and of the false values, but it would require a little too much explanation.

Numbers are represented as a sequence of base 10 digits, like `256`, possibly including a decimal point, as in `3.141593`. There's a special syntax to enter numbers in other bases.

Strings are enclosed in double-quotes; there are some tricks here, like how to include a double-quote in a string—`"""` is no good, because the enclosed (second) `"` terminates the string: you have to *escape* it with a backslash like this: `"\""`. There are also other "escapes" so that you can include control characters and such; see "String Type" in the *Elisp* manual.

Symbols look rather like strings without quotes (they don't need quotes because they won't contain spaces); you can just type their names. As discussed above, a function is typically represented by the symbol that names it (though for the Elisp programmer, there are other possibilities) and so uses the syntax of symbols.

[64] I can't imagine why you would want to change this variable, but let's ignore that.

[65] The word "globally" means the variable is *not* buffer-local; if it were, it would say "(buffer-local)" instead.

[66] These weird names are enshrined in the depths of Lisp history.

Lists are simply zero or more space-separated instances of any types enclosed in parentheses. The empty list is `( )`. There's no problem nesting lists: this list contains two values, a string followed by a list of three numbers: `("foo" (1 2 3))`.

This should be enough syntax for you to enter values at the `set-variable` prompt.

File- and Directory-Local Variables

Elisp also lets you initialize buffer-local variables inside arbitrary files: these are called *file-local variables*. When you visit such a file, the variables are automatically given their declared values in the buffer that the file initializes. This is especially useful as a way to set the Major Mode in which the file should be edited—see *Mode via File-Local Variable*—but you can set additional variables too (subject to Security limitations).

You can also set buffer-local variables on a per-directory basis; this is very convenient when you would otherwise be repeatedly setting (or forgetting to set...) the same file-local variables every time you add a file to a directory; see "Directory Variables" in the *Emacs* manual.

Hooks

An essential part of Emacs's customizability is provided by *hook* variables. They cleverly solve the problem of how you can customize, in your Init File, dynamic things that *haven't happened yet*, like all future buffers in some particular Major Mode, or an Emacs application that you haven't started yet (like Eww (the web browser) or Dired the file manager), or a third-party application like Magit that doesn't even ship with Emacs.

A hook is nothing more than an ordinary variable that's used in a conventional way by Emacs programmers. The value of a hook is a list of functions, such that at some documented and distinguished time—like when you visit a file in, say, `python-mode`, or pull up a web page in Eww, or start playing an audio file in EMMS—the functions are executed, or *run*.

Most hooks have a default value of the empty list: when the hook is run, nothing happens! But the important point is that you can add your choice of functions to the hook to cause magical things to occur. For example, you might add the function `flyspell-prog-mode` to the `python-mode-hook` variable to enable spell-checking of Python comments. Now you'll get this spell-checking in every Python file that you visit.

Minor Modes are a very common class of functions to add to

hooks, as is a function that changes the value of one or more buffer-local variables, whether one of the 130 predefined buffer-locals, or one defined specifically by a Major Mode for customization purposes. You can also write a function yourself to do any crazy thing that no one else could have thought of in advance, like send an email to somebody mentioning that you've started editing that Python file.

Hooks are almost always set in the Init File, rather than via `M-x set-variable`; see *Programming the Lisp Machine*.

Help, Discovery, and Documentation

All kinds of help for Emacs is never more than a keystroke away — no need to switch to a web browser. The Help system (commands on the prefix key `C-h` and also the function key `F1`) provides quick access, especially for known-item searches ("what is", "where is", "what does it do"). The Apropos facility is more like a Google search, used when you want to do something but don't know what commands or Modes or subsystems are available to do it (a query like "version control diff", say). Finally, Emacs has a built-in hypertext documentation reader, called Info, for long-form, book-length documentation. To enter it, type `C-h i`. See the *Info* chapter for more information.

Help

Emacs's extensive online help is available via the *help key*, `C-h` [67]. `C-h` is a prefix key. Type `C-h` twice to get a window describing all the following commands and more (a `SPC` will scroll this window). Some of the most useful help commands are:

[67] *N.B.*: in non-graphical mode, it's impossible for a program to distinguish `C-h` from `<backspace>`, so you'll need to use either `<f1>` or `ESC x help` for help in this case.

`C-h C-q (help-quick-toggle)` Toggles a quick help Buffer on and off that summarizes 30-odd keystrokes in six categories.

`C-h a (apropos-command)` Prompts for keywords and then lists all the commands whose names match. If you've forgotten the name of the command that counts words, `C-h a word count` will reveal it.

`C-h k (describe-key)` Prompts for a keystroke and describes the function bound to that key, if any. If you remember `M-=` but can't recall what it is, use `C-h k` (it's `count-words-region`).

`C-h w (where-is)` Prompts (with Completion) for the name of a function and tells you (in the Echo Area) what keystrokes will invoke it. If you cheekily type `C-h w where-is`, you'll see: `C-h w`, `<f1> w`, `<help> w`.

`C-h o` *(`describe-symbol`)* Prompts (with Completion) for the name of a function, a variable, or a Face[68] and describes all the matches. If you remember `count-words-region` but not what it does, `C-h o count-words-region` will tell you. (`C-h f` will do the same but only for functions, and `C-h v` only for variables, if you want to narrow it down.)

[68] A *Face* is a font with associated styles, such as color and slant; see Faces and Fonts.

`C-h m` *(`describe-mode`)* Describes the current Major Mode and its particular key bindings.

`C-h r` *(`info-emacs-manual`)* Enters the Info hypertext documentation reader at the Emacs manual, which contains many hundreds of pages of documentation.

`C-h p` *(`finder-by-keyword`)* Runs an interactive subject-oriented browser of installable Emacs packages[69]. These lists of packages are actually presented by the package manager itself, so you can directly install packages from here.

[69] Note that this does *not* include the thousands of third-party packages available in community repositories; see *The Package Manager* for that.

`C-h t` *(`help-with-tutorial`)* Run the Emacs tutorial. Have you done this yet?

There are 39 more help commands on `C-h`, which `C-h C-h` will reveal.

Of the commands I list above, `C-h k`, `C-h o`, `C-h f`, `C-h v`, `C-h m` (and a few of the other 39) bring up a Help Buffer. This is something of a simplification, but there are three main varieties of the Help Buffer:

- help for commands and functions, whether acquired via a keystroke or via a command name
- help for variables
- help for Modes

Let's see what these are like.

The Help Buffer

Let's get help from `C-h k` for whatever `C-x C-b` is! This is the same kind of buffer you'd get from `C-h f` (`describe-function`).

First note that the help pops up in its own buffer (named `*Help*`) in a new window (stealing some screen real estate from the `PKGBUILD` buffer I was looking at); the buffer is in `help-mode` (which of course usefully redefines some keystrokes).

Often a quick glance at this buffer is enough to answer your question and you just get rid of it with a quick `C-x 1` (`delete-other-`

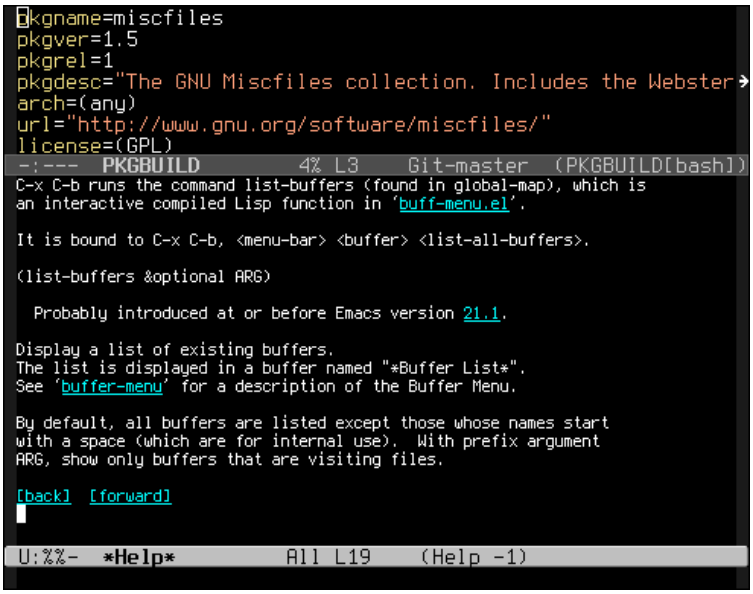


Figure 8: Help for key `C-x C-b`

windows), perhaps after giving it a quick scroll with `C-M-v` (`scroll-other-window`).

If you're in an investigative mood, you might jump into the help buffer with `C-x o` (`other-window`), where you can exploit its clickable buttons (cyan text) and the the key bindings of `help-mode`.

Parsing the Help Buffer

The first line identifies the function that `C-x C-b` runs: `list-buffers`, and tells us which *keymap* (`global-map`) the keystroke was found in[70].

It also tells us what kind of a function `list-buffers` is — "an interactive compiled Lisp function"; other possibilities include "built-in function" (which would mean it's implemented in C, rather than Elisp) — and it tells us which file of source code the function is defined in. You don't need to worry about any of this as a person just learning to use Emacs, but it isn't just idle chat: the cyan color of the file name means that it's a hypertext link, and if you "click" it (with mouse button 1 or by hitting return) it will take you directly to the definition of that function in that file and you can read the source code yourself.

> As an aside: this is an incredibly powerful tool for learning how to extend Emacs. I guarantee that if you are wondering what function the back-arrow button in Firefox runs when you click it, you'll have to spend a lot of time plowing through the >1 GB of source code (after you download it) and cross your fingers when you search for "back". And if we were talking about the bold-face toolbar button in Google Docs or Microsoft Word, you wouldn't even be allowed to download the proprietary source code.

[70] For now, let's just say that keymaps hold key bindings, that there's a global one, one for the major mode, and one for each minor mode in action at any moment, and they're searched in order from most precise to most general; this is how Emacs customizes keystrokes to do mode-specific things.

The next paragraph lists all the key bindings which run `list-buffers` — this is just what `C-h w` (`where-is`) would tell you.

The next line ("`(list-buffers &optional ARG)`") shows you how you would call the `list-buffers` function if you were writing Elisp, and after that, how old this function is in terms of the Emacs version number (this is mostly useful for programmers who might not want to write code using a new bleeding-edge function that won't be available in older Emacsen[71]).

[71] "Emacsen" is the official plural of "Emacs"; see also *The Jargon File*.

The remainder of the buffer describes precisely what `list-buffers` does. This text may include more hyperlinks to other, related, functions or variables (like `buffer-menu` here).

The help for a command can be extensive. But this is because the documentation includes *everything* an Elisp programmer might need to know; usually the first line or two tells you everything you need for interactive use.

Finally, if this isn't the first help buffer you've popped up in this Emacs session, at the bottom of the buffer will be a button labeled "[back]" which will take you to the previous help buffer you looked at. Once you've gone back, there will be a "[forward]" button to return you to where you came from. These are just like the back and forward buttons in your web browser and make it easy to browse through the hypertext of the Emacs help system. Note that there's really only one `*Help*` buffer, to keep from cluttering your Emacs; the navigation buttons recreate the previous text in the same `*Help*` buffer.

I mentioned that the help buffer is in Help Mode. This gives you 25 useful key bindings for use when you're in the `*Help*` buffer. For example, `SPC` is bound to `scroll-up-command` and `S-SPC` to `scroll-down-command` for easy reading. `C-c C-b` and `C-c C-f` are keyboard equivalents of the "[back]" and "[forward]" buttons. `TAB` and `<backtab>` (a.k.a `S-TAB`) take you to the next and previous clickable button respectively.

Help for a Variable

Now let's look at the help for the variable `completion-styles`, which we could see by executing `C-h o completion-styles` (or `C-h v`).

It's very similar to the help for a function, but it tells you right up front the most important thing about a variable: what it's current value is (here, the list of symbols `(basic partial-completion substring initials flex)`). Interestingly, it also tells you that its original value was `(basic partial-completion emacs22)`: this is the default value in a fresh Emacs: I changed it to demonstrate this feature. There may also be a hyperlink into the Customize facility,

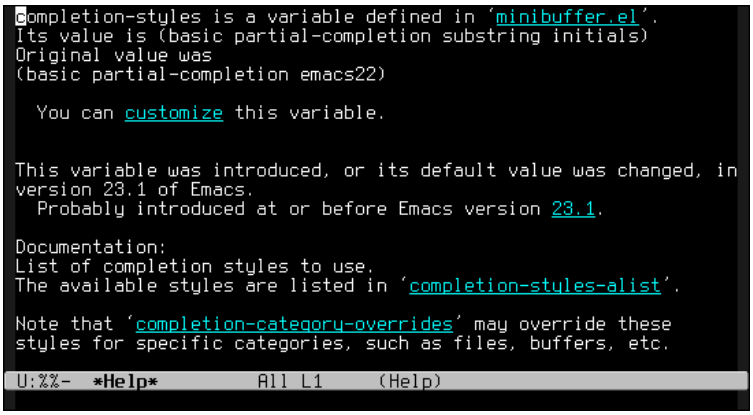


Figure 9: Help for variable `completion-styles`.

as here. The rest of the buffer is the documentation for the variable, with the same features as for functions.

For some variables, the help will say "Automatically becomes buffer-local when set." This means that the variable can have distinct values in different buffers, which is very useful for customization. For some variables, a buffer-local value doesn't really make a lot of sense, like `confirm-kill-emacs`, which lets you specify whether you want to be asked to confirm your intention when you give the exit command. But you may well prefer the values of other variables to vary from buffer to buffer or Mode to Mode, such as `indicate-empty-lines`, `fill-column`, or `truncate-lines`.

The help for some variables may also address the *safety* of the variable with a statement like "This variable is safe as a file local variable if its value satisfies the predicate 'integerp'."; see *Security Concerns*.

Help for a Mode

To get help for a Major Mode, just switch to a buffer that's in that Mode and do `C-h m`. The help buffer gives a description of the Mode, and lists all the Mode-specific key bindings. In addition, each enabled Minor Mode is described separately.

You can also access Major Mode help from any Buffer using `C-h f` and the name of the Mode, e.g. `C-h f org-mode`.

Discoverability via Apropos

Most of the Help commands described above answer specific questions about known items: what is this key? what does this function do? what kind of values can I set this variable to? The Apropos facility is how you search for unknown functions and variables related to what you want to do.

We've been introduced to the Apropos facility via `C-h a` above. This is `M-x apropos-command` which searches for commands by name. *Command* is the technical term for an *interactive function*: that is, a function you can call via a key binding or with `M-x`. The reason for making this distinction is purely practical. Emacs has tens of thousands of functions, most of which would only ever be called by an Emacs Lisp programmer. Commands are functions that are likely to be useful to the non-programmer (or to the programmer when she's acting like a non-programmer).

If you're interested in seeing non-command functions as well, you can give `C-h a` an argument (e.g. `C-u C-h a`).

Even more broad-minded is just plain `M-x apropos`, which includes all functions, variables, and faces.

If you want to limit your search to variables, you can use `M-x apropos-variable`. But there are other Apropos commands to make finer distinctions among variables:

`M-x apropos-user-option` only considers user-customizable variables (sometimes called *options*)

`M-x apropos-local-variable` only considers buffer-local variables defined in the current buffer

All of the above commands are only searching by function or variable *name*, to avoid overwhelming you. But you can include in your search all the text of the function's or variable's documentation with `C-h d` (`apropos-documentation`). This is just like `C-h a` but instead of limiting its search to the names of *commands*, it includes all symbols (like variables) *and* also searches the full text of the documentation of these symbols. This is a much broader search, and for reasons of both speed and concision, it limits the search to the standard built-in Emacs commands. If you give `C-h d` an argument, i.e., `C-u C-h d`, it searches the documentation of literally all symbols in your running Emacs, including those from third-party packages you may have loaded.

Finally, you can also search the *values* of variables with `M-x apropos-value`. This is a pretty big search. My Emacs at the moment has 15,121 defined variables, and some of them have pretty big values.

The Apropos Query Language

All the Apropos commands use the same query language. Your query can take any of the following three forms:

a single word all the results must contain this word

two or more words all the results must contain at least two of these words

a regular expression all the results must match this regular expression.

Additional Information

The Help key has several additional subcommands that provide access to more information. Some of these are shortcuts into the Emacs or Elisp manuals in Info, but some are standalone files.

`C-h C-a` Information about Emacs (recreates the splash screen you saw when you started up Emacs).

`C-h C-c` Emacs copying permission (displays the complete text of the GNU General Public License, which gives you your freedom to copy, modify, and redistribute Emacs and its source code).

`C-h C-d` Instructions for debugging GNU Emacs. This is for real hard-core programmers hacking on Emacs to fix deep bugs.

`C-h C-e` External packages and information about Emacs.

`C-h C-f` Emacs FAQ (the Frequently Asked Questions list).

`C-h C-m` How to order printed Emacs manuals.

`C-h C-n` News of recent Emacs changes; see *Updates and Bugs*.

`C-h C-o` Emacs ordering and distribution information. This used to provide postal addresses you could write to in order to get copies of Emacs mailed to you on giant 9-track magnetic tapes to load on your mainframe! Nowadays, it just contains a few URLs and notes how you can make donations to the Free Software Foundation.

`C-h C-p` Info about known Emacs problems. This is a broad summary of the standout Emacs bugs; the real bug list is available on the Web in the Bug Tracker, which is also available in Emacs via the `debbugs` package; see Reporting Bugs.

`C-h C-t` Emacs TODO list. If you're a Lisp or C programmer and want to contribute to the development of Emacs, you can start here.

`C-h C-w` Information on absence of warranty for GNU Emacs.

Info: The Emacs Documentation Reader

Emacs has a built-in documentation reader called *Info*. It dates from 1985 and actually predates GNU Emacs (it was present in ITS TECO Emacs) and was one of the earliest freely available hypertext systems, predating the World Wide Web by about fourteen years.

The Emacs manual is the most important Info document, but Emacs ships with 66 additional manuals, comprising 418,338 lines of text, describing various subsystems and major modes (e.g. Org, Gnus, Calc).

Info documents are written in their own markup language, called Texinfo, and Texinfo is used to document many other non-Emacs software projects[72]. The non-Emacs packages I've installed on my Arch Linux system include an additional 66 Info manuals. (Non-Emacs users read these manuals with the `info` command-line documentation reader, which is sort of like a clone of the Emacs Info system for Vim users and other Emacs-averse types, I suppose.)

[72] Texinfo is a front-end to the TEX typesetting system, specifically designed for software manuals, and can generate PDFs, HTML (single-page or multi-page), and more, in addition to its default of generating Info manuals for Emacs.

The main entry points for Info are:

`C-h i` *or* `M-x info` Lists all installed manuals, including the Emacs manual (there will be at least sixty, if you've done a full install of Emacs).

`C-h r` *or* `M-x info-emacs-manual` Skip the top-level list and read the Emacs manual directly.

`C-h R` (*`info-display-manual`*) Open a specific manual by name, with Completion. `C-h R calc` would go directly to the Calc manual, for example.

`C-h F` (*`Info-goto-emacs-command-node`*) This is like `C-h f` (`describe-function`)—it prompts for the name of an Emacs function—except it tries to find a discussion of the function in the Emacs manual (while every Emacs function has Help documentation, they aren't all described in detail in the manual).

`C-h K` (*`Info-goto-emacs-key-command-node`*) This command is to `C-h k` (`describe-key`) as `C-h F` is to `C-h f`.

Info is of course documented in its own Info-manual, which you can read with `C-h R info` (or just navigate to it from the main Info menu via `C-h i`).

Info has its own interactive tutorial[73], modeled on the Emacs Tutorial, to teach you how the hypertext system works. Ideally, you should take it before you start using Info; you can start the tutorial by typing `h` (`Info-help`) from anywhere in any Info manual. But you can read any Info document in its entirety by just hitting `SPC` (`Info-scroll-up`), so feel free to just dive in; if you want more or need help, hit `h`.

[73] It's actually *Chapter 1: Getting Started* of the Info manual.

Figure 10: Typical Info node with menu

A typical page in an Info document (called a *node*) looks like that in Figure 10. The very first line is a *header line* with next, previous, and up navigation links for mouse navigation. The next line is a *breadcrumbs line* that shows your position in the document hierarchy with clickable links. The rest of the page consists of text, typically with clickable hyperlinks to other pages. Often there is (as here) a *menu* of links to subsections of the chapter; these are exactly the same kind of links as appear interspersed in the text.

You can move around in Info within a node, or between nodes. The usual motion and scrolling commands work fine for the former, along with the convenient bindings `SPC` and `DEL` for scrolling up and down by screenfuls.

Moving between nodes is more interesting. If you're looking at the bottom of a node[74], `SPC` will move on to the next node, in the order you'd use to read the entire document (`DEL` does the same backwards if you're at the top of a node).

[74] A node could be any number of screens long.

Like any hypertext, an Info document has a tree structure[75]. While `SPC` moves node by node through the whole tree in reading order

[75] Of course, it's really a graph; see *Hyperlinks* below.

(that's a depth-first traversal), you can cut across the branches at any level (breadth-first-wise) with `n` (`Info-next`) and `p` (`Info-prev`). So, if you're in the node for Chapter 3, `n` will go directly to Chapter 4, skipping all subsections of Chapter 3, and if you're in subsection 4 of section 2 of Chapter 6, `n` will go to subsection 5, and so on. `p` does the same thing backwards. In other words, `n` and `p` are the keyboard shortcuts for the `Next:` and `Prev:` links in the node's header line. `u` will go up to the parent of this node.

You can also move through nodes in the order in which you visited them: that is, move via your node-browsing history. The `l` (`Info-history-back`) command goes *left* to the last node you were in; more `l`'s go further back in time. The `r` (`Info-history-forward`) command goes *right*, forward in time, assuming you've already gone backward. These commands have no relation to the order of the nodes in the document, but only to the order in which you've read them. `L` (`Info-history`) takes you to a node containing the history of all the nodes you've visited, as a Menu.

Hyperlinks

Info documents wouldn't be hypertexts if they didn't have *hyperlinks*. These are exactly like the links in a web page and look similar: colorized and underlined. You can navigate from link to link in a node with `TAB` (`S-TAB` goes in reverse) and then follow a link by "clicking" on it (either with `RET` or the mouse). Info links can take you to other places within a node, to other nodes in the document, and also to nodes in other Info documents.[76] Links to places in the same node are formatted like footnotes.

[76] Info calls inter-node links *cross references*.

You can also follow any of the links in the current node (even if you can't see some of them) without navigating to them with `f` (`Info-follow-reference`), which prompts you for the text of the link. You can use Completion to complete any of the links in the node; note that Menu links and Footnote links are excluded from the Completion, because they have their own shortcut commands.

Menus

Many Info nodes have *menus*, especially in the first node of a document and in each chapter. Menus are nothing more than a list of hyperlinks and work the same way; it's just a convention for organizing an Info document. Menus typically list all the children of a given node: that is, a chapter menu will list all the sections in that chapter, and a section menu all its subsections.

You can use Completion to select a Menu item by typing `m` (`Info-`

menu), analogous to the f command for cross references, and the digit keys will jump directly to the node of the corresponding menu item: e.g., 3 would jump to the node named in the 3rd menu item and so on.

Searching

Since an Info node is just a buffer, you can obviously search within it with the usual search commands like C-s (isearch-forward), M-x occur, and the like. Incremental search commands like C-s will beep when you get to the end of the node, but if you force the search with one more C-s then instead of wrapping to the beginning of the buffer, they will skip ahead to the next hit in the next node of the document.

Indexes

In addition to full text searching, most Info documents are actually manually indexed by their authors, and everybody knows that a good index, what with synonyms, related terms, and inversion, can offer accessibility that full text searching can't. In addition, an index allows for the possibility of Completion on index terms!

An Info document can have one or more indexes—Emacs-related documents will often have separate indexes of Key Bindings, User Options, Commands, Variables, and Concepts (the Emacs manual has all of these).

The index pages of a document are always listed at the end of the top-level menu of the document (its table of contents), but from any node the i (Info-index) command prompts you for an index term, with Completion, from any of the document's indexes. Since a given term can point to any number of nodes, it will take you to the first occurrence, and if there are more, you might see a message like this in the Echo Area:

```
Found 'INDEXTERM' in Concept Index.  (20 total; use ',' for next)
```

and indeed, the comma key will step you through all the hits.

Alternatively, you can instead use I (Info-virtual-index), which presents the same hits as i but lists them all in a dynamically-generated Menu.

You can also search across *all* sixty-plus Info documents at once with M-x info-apropos, the search-engine of Info commands. It works like other Apropos commands but targets the text of the indexes of all installed Info files, and generates a dynamic Menu page from the hits.

Higher-Level Navigation

You can jump directly to the top of the current Info document, with its master Menu table of contents, with `t` (`Info-top-node`), and the `d` (`Info-directory`) command goes to the Menu at the root of the entire Info system, listing all installed Info documents (the same place that `C-h i` takes you to).

Write Your Own Manual

If you are writing a book-length document, especially a manual for software, and very especially a new manual for an Emacs subsystem or Mode, you might consider using Texinfo format.[77] You'll get many output options—PDF, HTML, DocBook, EPUB, and of course Info, which can be read in Emacs and even by non-Emacs users via the `info` command-line reader that's standard on most Unix systems. And Emacs is of course especially suited for authoring with its Texinfo Mode; see *Emacs For Writers* for more information.

[77] If you're not particular about low-level layout details, you can use Texinfo for any kind of book. For an example, see Abelson *et al.* in the Bibliography.

Messages, Errors, and Lossage

Messages

Various brief messages appear in the Echo Area from time to time. This includes error messages (like, trying to save a file that you don't have permission to write), and also informational messages. Some commands exist only to print informational messages, such as `C-x l` (`count-lines-page`), which tells you how many lines there are in your buffer[78]:

```
Page has 5549 lines (2407 + 3143)
```

[78] Technically, and as the command name indicates, this is how many lines are in the current *page* of the current buffer; see *Editing with Textual Objects* for information about pages.

If you miss a message like this, or if you want to make a copy of the message, you can use `C-h e` (`view-echo-area-messages`). This pops up the `*Messages*` buffer, which you can switch to for copies of the *N* most recent[79] Echo Area messages. It's just a buffer like any other, so you can copy and paste from it.

[79] *N* is determined by `message-log-max`, 1,000 by default.

There's a separate buffer for *warnings*. Warnings are obviously like errors, but less severe. While errors go to the Echo Area, and behind the scenes are copied to the `*Messages*` buffer, warnings instead go to a separate `*Warnings*` buffer, and when a warning is generated this buffer pops up and is very noticeable. It seems counterintuitive that warnings should be more in-your-face than errors; I think the reason is two-fold: 1. the special handling of warnings is a relatively new feature, dating from about Emacs version 22; and 2. an error terminates whatever function raised it — it beeps, and you'll look at the Echo Area — whereas a function that generates a warning will continue with what it was doing, but wants you to know something that you might need to act upon. There's no special command to pop up the `*Warnings*` buffer; if you've deleted the window that popped up, and you want to reexamine it, you can just switch to it by name with `C-x b` (`switch-to-buffer`) (which you can also do to get to `*Messages*`).

What Just Happened?

Occasionally as you're working, you might suddenly notice that something unexpected has happened — perhaps a chunk of text has disappeared before your eyes, or you're suddenly in a completely different location! What happened?

Almost certainly this means you accidentally hit some unintended combination of keystrokes, and since so many such combinations are bound to commands, this means you inadvertently told Emacs to do something.

If a change to your text occurred, you can just Undo it and continue on. While you can't Undo a location change, you can use the Mark Ring or the Global Mark Ring to return to where you were. But you might want to know what keystrokes and command you invoked so that you can avoid hitting it in the future — or perhaps you've discovered a new useful command to use intentionally!

The `C-h l` (`view-lossage`) command[80] pops up a Help Buffer showing the last 300 keystrokes you've typed. The lines look like this:

[80] "Lossage" is an old computer jargon term meaning "the result of a bug or malfunction" (*The Jargon File*).

```
M->                             ;; end-of-buffer
q                               ;; quit-window
C-x b                           ;; switch-to-buffer
c                               ;; self-insert-command
o                               ;; self-insert-command
```

showing you the keystroke and the command name. You can ask for help for any of the command names (with `C-h f` (`describe-function`)) which can help you figure out what happened.

The Minibuffer

Sometimes a command needs to ask you a question. `C-x C-f` asks, "What file did you want?" `C-x b` asks, "What Buffer did you want?" `M-x` asks, "What long-named command did you want me to execute?"

To get your answer, Emacs uses its most general and most powerful data structure, the Buffer, but to avoid constantly popping up a new one and messing with your Window layout, it uses a special Buffer called the *Minibuffer* (see "Minibuffer" in the *Emacs* manual), which is always displayed in a compact form in the same location. In fact, the Minibuffer reuses the fixed Window that's used for the Echo Area at the bottom of the screen. The question, or prompt, appears in the Echo Area, which is automatically focused to receive your response, and when you hit `RET`, the little excursion is over.

The advantage of using a Buffer, rather than something like a modal GUI dialog widget, would be that you already know how Buffers work, and you can interact with this Minibuffer using the same commands you use all day long.[81]

[81] Also, one of the best things about Emacs is that it is almost 100% modeless, in the sense of "modal dialog".

The Echo Area, and thus the Minibuffer's Window, is normally only one line high — just enough space for a typical prompt and your response, though it will dynamically expand to more lines as needed, and you can change the default height if you like.

The Minibuffer has its own Major Mode, with a few specialized key bindings. Most notable is that hitting `RET` is how you indicate that you're done typing your answer: `RET` deactivates the Minibuffer and your cursor is returned to the Window it was in when the interaction started.

While it has some special behavior and a few restrictions, the Minibuffer is otherwise very much a fully-functional Emacs Buffer. All the usual editing commands work — you can move around within it to correct mistakes, you can even do fancy things like search within it, you can kill and yank text, use spelling correction, or anything else[82].

[82] Why would you need to search or spell-check within a one-line response to a question? Well, nobody specifically thought that it would be important to be able to do so: it's just that the Minibuffer is a buffer like any other, so of course it works!

Minibuffer History

In addition to the special treatment of `RET`, the Minibuffer's Major Mode provides convenient history commands. You can instantly recall your previous input — command name, filename, Buffer name... — with `M-p` (`previous-history-element`); subsequent `M-p`'s will go further back, and you can switch directions and go forward again with `M-n` (`next-history-element`) — the up- and down-arrow keys are synonyms. (Rather than navigating the history, `C-p` and `C-n` navigate multi-line input as in any Buffer — multiple lines, while atypical, are completely supported in the Minibuffer).

You can also search backward in the history with `C-r` (`isearch-backward`) or `C-M-r` (`isearch-backward-regexp`). You could, say, quickly pull up the last Org Mode file you edited with `C-x C-f C-r .org`, even if you last typed that filename days ago.

Note that any individual command can have its own distinct history list. This is typically done to tamp down the Completion possibilities for any given command to those that are most likely to be useful. Since the Minibuffer is used for all prompted inputs, if it only had one history list, then you'd have to wade through Buffer names, command names, color names, variable names — you get the idea — no matter what you were about to enter.

Instead, all the file-visiting commands, like `C-x C-f`, share a single history list which only contains filenames; likewise for `C-x b` and Buffer names, `M-x` and command names, etc.

Future *History*

One of the lesser-known features of the Minibuffer[83] is that its history extends into the future: that is, Emacs can predict inputs that you haven't typed yet! More prosaically, you could call these predictions, *defaults*. You access these defaults with `M-n` (`next-history-element`) — use it immediately after you've been prompted for input by some command and it'll offer up suggestions: if you're at the end of the history, the *next* history element is from the future!

[83] Well, I'm embarrassed to say I only figured this out recently!

For example, after `C-x b` (`switch-to-buffer`), `M-n` will offer up names of Buffers that you've recently visited (even if you haven't ever explicitly input their names). `C-x C-f` will do something similar, but in addition, if, before you invoked `C-x C-f`, Point happened to be in the name of an existing file, it will offer up that filename. Sometimes the things `M-n` comes up with can seem telepathic. (The flip side is that sometimes it won't have any guesses for you.)

Recursive Minibuffers

The Minibuffer is the sole, unified way to get prompted input, and you can use any commands you like when you're entering text there. So what happens if you type `M-x eww` to pull up a web page in the Emacs web browser. Eww is now using the Minibuffer to read a URL, prompting you with:

```
Enter URL or keywords:
```

Then you realize you don't remember the precise URL you need, but you know it's in a file. So you naturally type `C-x C-f` (`find-file`) so you can observe and copy that URL.

But no! Emacs will beep at you and refuse to execute `C-x C-f`, saying:

```
Command attempted to use minibuffer while in minibuffer
```

That is, you're in the Minibuffer (entering a URL) but `C-x C-f` now needs to use the Minibuffer to read a filename!

This is not really a limitation of Emacs, which actually has no problem allowing you to invoke the Minibuffer recursively to any (reasonable) depth. However, this feature is disabled by default — because it's been found to confuse Emacs newbies.

But this many pages into this book, you're no longer a newbie! While my example may be somewhat contrived, recursive Minibuffers are very useful and you'll probably want them several times in a day. I recommend turning them on with this snippet of code in your init file:

Init File

```
(setq enable-recursive-minibuffers t)
```

If you recursively invoke a Minibuffer and change your mind about it, just hit `C-g` (`keyboard-quit`) as usual; it will abort the most recent Minibuffer and you'll be back in the previous one and can complete your input there as you like.

Temporary Excursions

When you're entering information in the Minibuffer, you may occasionally realize that you don't actually know what you need to type, as in our URL example. You have to check something first.

The normal procedure is just to use `C-g` (`keyboard-quit`) to cancel the command that's using the Minibuffer, do your investigation, and then reissue the command. How very modal of you.

But you can instead just temporarily switch out of the Minibuffer with any command that switches Windows. Normally that would

be C-x o (other-window) but any Window-changing command, or clicking in another Window with the mouse, is fine.

Now you're in one of your "normal" Windows, and the Echo Area, instead of being blank, as usual, still contains the Minibuffer prompt and whatever else was displayed there when you jumped out: the Minibuffer is frozen the way you left it, waiting for you to return and finish what you were doing. In a graphical mode Emacs, you'll notice that the Minibuffer cursor has changed from a solid rectangle to a hollow one.

While you're away, you can do anything you like: continue editing, play a game with M-x tetris, copy some text you need for the Minibuffer: you can even, of course, use a command that uses the Minibuffer![84] You can stay away as long as you like. When you're ready to get back to where you left off, just navigate to the Minibuffer (again, C-x o or a mouse click is the most natural), and complete your action, perhaps yanking in some text you copied for the purpose. Hit RET to execute the patient, long-suffering command-in-progress, and you'll be returned to wherever you were when you started this excursion — the Window layout and your Buffer position will be restored as they were, even if, during your excursion, you changed Windows around radically. This is the essence of non-modal editing!

[84] Thanks to our Init File addition above.

Repeating Complex Commands

Among people who use Emacs mostly as a text editor, the Minibuffer is probably most heavily used to input file names, followed by Buffer names. But as you use Emacs for more things, the use of the Minibuffer to enter command names with M-x (execute-extended-command) probably dominates. So Emacs provides special history support for these.

We know that if you type M-x you can retrieve previous commands from the history with M-p, C-r, and M-r, but some commands have multi-part inputs. Consider M-x rgrep (see Meet the Greps). It's nice that the Minibuffer history helps you avoid typing all five characters of "rgrep" to run a *new* Rgrep, but what if you want to rerun a previous Rgrep exactly?

M-x rgrep prompts you for three things: a search term or regular expression, a file type wildcard pattern (e.g., *.org), and a base directory from which to start the search. You can use the history commands at each of these prompts, but that can be a little tedious if you just want to rerun the command exactly: M-x rgrep RET M-p RET M-p RET M-p RET M-p RET.

Instead, you can use C-x ESC ESC (repeat-complex-command). You

get a Minibuffer prompt showing your previous `M-x` command, in its true Elisp form; it might look like this:

```
Redo: (rgrep "minibuffer" "*.org" "~/txt/" nil)
```

Even if you're not an Elisp programmer (yet), this should be recognizable as your grep for the string "minibuffer" in Org Mode files contained (recursively) in `~/txt/`; just hit `RET` to re-run it, with no need to reenter the three parameters. You can edit the command beforehand (perhaps to tweak the regexp, or the file type, or the base directory)[85].

[85] This might occasionally require a superficial knowledge of Elisp syntax, such as quoting.

You can use the Minibuffer history (`M-p`, `C-r`, `M-r`) as usual here to choose a different prior command. Note that the history includes any command that used the Minibuffer, even if you invoked it via a key binding, so you'll find old friends like `C-x C-f` (`find-file`) and `C-x b` (`switch-to-buffer`) here as well.

You can view a Buffer of the *N* most recent[86] `M-x` commands with `M-x list-command-history`. The commands are in their true Elisp form, as for `C-x ESC ESC`, one per line. In this Buffer you can re-run the command at Point by typing `x` (`command-history-repeat`).

[86] *N* is determined by `list-command-history-max`, 32 by default.

Since the default command history list is so short, and since I think `RET` in this Buffer should execute the command at Point, I recommend this snippet for your init file:

Init File

```
(with-eval-after-load 'chistory
  (setq list-command-history-max 120)
  (define-key command-history-map (kbd "<return>") 'command-history-repeat))
```

An Aside Concerning Completion Frameworks

Note that alternative Completion frameworks, and Incremental Narrowing Frameworks in particular, may radically alter the nature of the Minibuffer, making it seem less like a normal buffer, and some of the things described in this chapter may not work precisely the same way.

Completion

Everyone is familiar with *completion*, perhaps under the name "autofill", which usually refers to the automatic completion of fields in forms. Web browsers, spreadsheets, and smartphone applications autofill via drop-downs, and Unix users are of course familiar with the TAB-completion of commands, options, and filenames in any conventional shell[87].

Emacs definitely had completion for the Minibuffer by 1985 and as a text-oriented computing interface that prioritizes the keyboard over menus, it's fundamental to using Emacs. Completion is pervasive: almost anytime Emacs prompts you for information — command names, variable names, filenames, color names, lists of words — completion is available; it's also available at Point in many buffers (e.g., to complete symbols and keywords in programming languages, as you type).

This is not to be confused with the *predictive autocompletion* or *autocorrect* for prose that you're used to from the text messaging app on your phone, where every word you enter is automatically turned into a typo for you![88] Instead, you can autocomplete natural language words via an explicit keystroke; Emacs calls this *expanding dynamic abbreviations*.

Neither is it to be confused with *template expansion*, where an entire complex piece of text, like say a `case` statement in a programming language, is expanded from one word.

As completion examples I'll use `M-x` commands, because the basic set of them is common to all Emacs users — filenames and buffer names are going to be unique to each person — but don't forget that it works the same for everything.

[87] The first substantial implementation of completion probably dates from its use in the TENEX operating system in 1969; then in the TENEX-inspired Unix shell `tcsh` in 1981.

[88] Though Emacs has third-party libraries for that, if you like.

A Shortcut to Completion

Emacs has a number of ways of performing completion that I'll call *completion frameworks*. The default framework is roughly the way completion has always worked since about 1985, but you definitely want to use a more modern framework of the type known as *incre-*

mental narrowing. Even here, Emacs has more than one choice.

I'm going to recommend you start right off with Vertico[89], which you can install from the GNU ELPA Package Repository; see Figure 11.

[89] There are many others in the Package Manager; I prefer Selectrum myself.

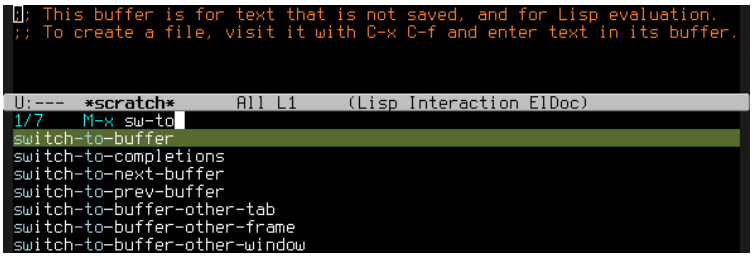


Figure 11: `M-x switch-to-buffer` via Vertico

You'll need to add this to your Init File and restart your Emacs[90]:

[90] Or set the Region around this snippet and say `M-x eval-region`.

Init File

```
(setq completion-styles '(partial-completion substring flex))
(unless (package-installed-p 'vertico)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'vertico)))
(with-demoted-errors "%s" (vertico-mode +1))
```

An incremental narrowing framework (INF) generally lets you complete a string (whether a `M-x` command name, file name, buffer name, or anything else) by typing a pattern consisting of clusters of adjacent letters separated by punctuation. So to complete the command `switch-to-buffer`, you can type `sw-to-bu` which rapidly narrows the matches down from 21,310 possible commands to a mere 7.

The entire line of one of the matches will be highlighted; this is the match that will be used if you hit `RET`. If `switch-to-buffer` is *not* highlighted yet, you'll need to either narrow it down further, by adding more letters, or, when the number of matches is small enough, just navigate to it with `C-n` or the down-arrow key.

If there are more than the default 10 matches, you can scroll through them until you spot the one you want, or edit your pattern (with the usual Minibuffer editing commands) to narrow it down further. The usual Minibuffer history commands work as well. See Table 4.

Done!

When your target is properly highlighted, you're done. Hit `RET` to select it. If you're completing a `M-x` command, the command will be executed. However, if you're entering a filename for, say, `find-file`

Table 4: The Main Vertico Commands

Key	Type	Action
`C-n`, ↓	Move	Move down to highlight next match
`C-p`, ↑		Move up to highlight previous match
`RET`	Done	Select the highlighted match
`C-RET`		Use the exact text that you typed
`C-v`	Scroll	Scroll down to reveal the next 10 matches
`M-v`		Scroll up to reveal the previous 10 matches
`M->`		Scroll to the bottom of the matches
`M-<`		Scroll to the top of the matches
`M-p`	History	Pull up the previous history element
`M-n`		Pull up the next history element

or a buffer name for `switch-to-buffer`, you may be intentionally typing a nonexistent name, to create a new file or buffer, which therefore can't possibly have a match! In this case, you use `C-RET` to select *not* the highlighted match, but the exact text you've typed, as is.

Complementary Packages

Vertico is designed to be enhanced and customized via a set of complementary packages. I also recommend installing Marginalia, which provides *annotations* in the Minibuffer adjacent to command names, file names, buffer names, and more.

Init File

```
(unless (package-installed-p 'marginalia)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'marginalia)))
(with-demoted-errors "%s" (marginalia-mode +1))
```

Now `M-x sw-to` looks like Figure 12 and `C-x C-f` looks like Figure 13:

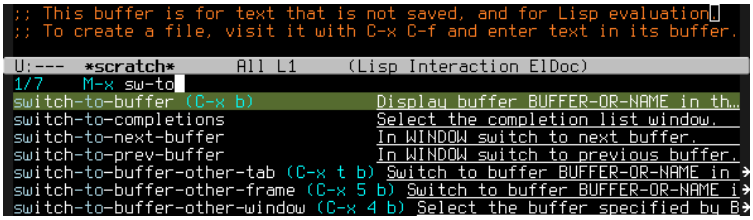


Figure 12: `M-x` with Marginalia

Other Incremental Narrowing Frameworks

I think Vertico is one of the best INFs, but Emacs has a few other built-in INFs to choose from, and more in the Package Manager. The

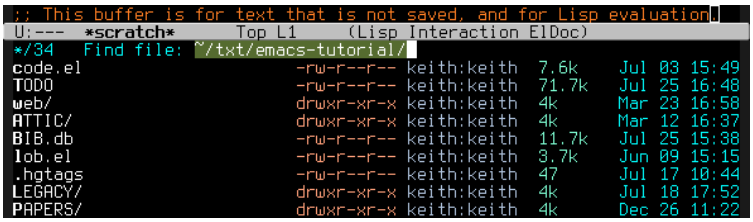


Figure 13: `C-x C-f` with Marginalia

built-in INFs are Icomplete (`M-x icomplete-mode`), Ido (`M-x ido-mode`) ("Incremental Do": see the *Ido* manual) and Fido (`M-x fido-mode`). Unlike most modern INFs, their interface is horizontal. When you hit `M-x`, you'll see something like this:

```
M-x {execute-extended-command | enable-theme | dired-at-point | ...}
```

You navigate through the matches with the left- and right-arrow keys. (I'm showing an abbreviated version; you'll typically see half-a-dozen candidates, possibly spread across at most two minibuffer lines.) Note that you don't need to hit `TAB` to see these candidates: that's a big part of what makes an INF more efficient. These will narrow as you type.

They all work together, and if you want to use them, you should probably turn all three of them on in your Init File:

```
(icomplete-mode +1)
(ido-mode +1)
(fido-mode +11)
```

Most modern INFs have chosen, like Vertico, to go for a vertical presentation of the candidates, using a multiple-line expanding Minibuffer; this gives more room for long command and file names, and in some frameworks, useful extra information like that provided by Marginalia.

The other vertical INF in the GNU package repository is Ivy; it has more built-in features, which are quite powerful, but due to its complexity, it may not interact as well with some Emacs subsystems. (Vertico aims for 100% compatibility and comes very close by being simple.)

Third-Party INFs

The king of Emacs INFs for some time had been Helm, which dramatically remakes dozens, perhaps hundreds of Emacs commands (though you can configure it to be more or less intrusive). Its completion buffer can take up the bulk of your screen and present scads of additional information. It allows you to do a variety of actions (like, deleting files) in mid-completion, and its fans are very devoted. I find

it to be too bulky, too intrusive, and too complex and confusing. It's also now apparently abandonware.

For Emacs purists who want to do their editing with mental powers alone, there's Icicles. It's amazingly powerful and I used it for some time, but I ultimately abandoned it because I had trouble getting it to work with Tramp; in addition, the author chooses not to make it available via the Package Manager and so it's daunting to acquire[91].

[91] It's published on the EmacsWiki; I wrote a 67-line Makefile to automate downloading and upgrading it.

There are other options like Raven, Sallet, and Snails, but I have recently settled on Selectrum, one of the newest (but surely not the last) Emacs INFs. For me it combines simplicity and utility perfectly, and instead of taking a kitchen-sink approach to features, can use the same optional add-ons (like Marginalia) as Vertico.

Completion in Normal Buffers

In this chapter, we've discussed completion in the Minibuffer, but Emacs also does completion in normal buffers. It comes in two flavors: explicitly-activated completion at Point, and implicitly-activated completion via a popup menu.

For the former, when you're half-finished typing a word, you hit `M-/` (`dabbrev-expand`), and Emacs completes the word for you. This an amazing feature and an essential skill to pickup; see *Completion at Point*.

For the latter, you can arrange to have a (lightweight, non-GUI, plain-text) menu pop up as you're typing, showing you possible completions, any of which you can select by quickly navigating to it with the arrow keys. This popup completion isn't typically enabled for ordinary words in prose, but rather in buffers whose Major Mode usefully limits the candidates. In particular, in programming language modes, where library functions and symbols in the buffer are presented. See *Pop-up Menu Completion*.

References

- Free Software Foundation. 2020. *Interactive Do.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/ido.html`. Read in Emacs with `M-x info-display-manual RET ido RET`.

- [Krehel, Oleh]. *n.d. Ivy User Manual.* `https://oremacs.com/swiper/`. Read in Emacs with `M-x info-display-manual RET ivy RET`.

What is Text?

I call Emacs the "Plain Text Computing Environment", but what exactly is *text*?

The notion of text is fairly intuitive to Unix users, elderly computer users of any stripe, and programmers, but may actually be puzzling to younger users who have spent all their lives interacting with GUI desktop applications, or tablets and smartphones only.

Classically, text consists of the *printing characters* from the ASCII[92] character set: that is, upper- and lowercase letters, digits, punctuation marks, and a few whitespace characters. These are the characters that make up the bulk of your keyboard. Here's the complete ASCII character set: ignoring whitespace, the printing characters are those from (decimal) 32 through 126:[93]

[92] American Standard Code for Information Interchange.

[93] The funny 2- and 3-letter names in the table are the historic 1967 abbreviations for the official Teletype names of the non-printing characters.

Dec	Hex		Dec	Hex		Dec	Hex		Dec	Hex		Dec	Hex		Dec	Hex		Dec	Hex	
0	00	NUL	16	10	DLE	32	20		48	30	0	64	40	@	80	50	P	96	60	`	112	70	p
1	01	SOH	17	11	DC1	33	21	!	49	31	1	65	41	A	81	51	Q	97	61	a	113	71	q
2	02	STX	18	12	DC2	34	22	"	50	32	2	66	42	B	82	52	R	98	62	b	114	72	r
3	03	ETX	19	13	DC3	35	23	#	51	33	3	67	43	C	83	53	S	99	63	c	115	73	s
4	04	EOT	20	14	DC4	36	24	$	52	34	4	68	44	D	84	54	T	100	64	d	116	74	t
5	05	ENQ	21	15	NAK	37	25	%	53	35	5	69	45	E	85	55	U	101	65	e	117	75	u
6	06	ACK	22	16	SYN	38	26	&	54	36	6	70	46	F	86	56	V	102	66	f	118	76	v
7	07	BEL	23	17	ETB	39	27	'	55	37	7	71	47	G	87	57	W	103	67	g	119	77	w
8	08	BS	24	18	CAN	40	28	(	56	38	8	72	48	H	88	58	X	104	68	h	120	78	x
9	09	HT	25	19	EM	41	29	)	57	39	9	73	49	I	89	59	Y	105	69	i	121	79	y
10	0A	LF	26	1A	SUB	42	2A	*	58	3A	:	74	4A	J	90	5A	Z	106	6A	j	122	7A	z
11	0B	VT	27	1B	ESC	43	2B	+	59	3B	;	75	4B	K	91	5B	[	107	6B	k	123	7B	{
12	0C	FF	28	1C	FS	44	2C	,	60	3C	<	76	4C	L	92	5C	\	108	6C	l	124	7C	|
13	0D	CR	29	1D	GS	45	2D	-	61	3D	=	77	4D	M	93	5D	]	109	6D	m	125	7D	}
14	0E	SO	30	1E	RS	46	2E	.	62	3E	>	78	4E	N	94	5E	^	110	6E	n	126	7E	~
15	0F	SI	31	1F	US	47	2F	/	63	3F	?	79	4F	O	95	5F	_	111	6F	o	127	7F	DEL

You'll notice right away that this 1963 American standard doesn't really accommodate non-English speakers, which is why there are so many other character sets[94]. Nowadays, *text* would be defined to include all the printing characters, international and specialized, in the enormous standardized Unicode character set (Emacs knows 64,414 of them by name) and the 267-odd other character sets Emacs supports.

[94] There are many! One Unix utility handles 2,036 different character sets!

The Structure of Text

Lines are the fundamental unit of organization for most (but not all) text. Text consists of a sequence of lines, and lines are separated by end-of-line characters.[95] We usually loosely call the end-of-line character a *newline* (but see *International Character Set Support* for the gnarly details). You can enter a newline, and thus begin a new line, by hitting the key Emacs calls `RET` or `<return>`, which on your keyboard might also be labeled `ENTER`.

The end of a line at the very end of a Buffer is somewhat ambiguous[96]. Suppose we have a Buffer whose text consists of "foo", a newline, and "bar"; that's 7 characters, but how many lines is it? In your Buffer it looks like:

```
foo
bar
```

and to me, that's unquestionably two lines. Emacs agrees. `C-x l` (`count-lines-page`) reports:

```
Page has 2 lines (0 + 2)
```

and — further confirmation — if we invoke `M-x display-line-numbers-mode`, the buffer looks like:

```
1 foo
2 bar
```

But there's no newline after "bar"! If we add one, the buffer *looks* the same, and `C-x l` and `display-line-numbers-mode` both still report two lines. In other words, the number of lines is not necessarily exactly the same as the number of newline characters.

Unfortunately, this ambiguity is simply a fact of computing life. The good news is, 1. it doesn't usually cause any problems, and 2. Emacs has extensive facilities for dealing with it; see *Manipulating Plain Text* for details.

When Emacs was fresh and new in the 1970s, people entering prose text would typically hit `RET` after typing 72 characters or so, and almost always before 80.[97] Paragraphs were typically separated by an empty or blank line (i.e., a line consisting solely of a newline, or possibly a sequence of whitespace characters followed by a newline), or by a line with leading indentation (i.e., a few spaces), or both: exactly how you'd type it on a typewriter. Emacs's Text Mode (see "Text Mode" in the *Emacs* manual) is designed for this kind of prose text and has support for automatic wrapping, indenting, and filling of paragraphs.

But there's no limit to the length of a text line, and in fact in the modern world, the current convention is that each *line* of typed text

[95] Data that doesn't consist primarily of printing characters is generally called *binary data* and comes in innumerable formats; one example would be an image format like GIF. Emacs is happy to work with binary data too, but it's not really its main thing.

[96] As is *whitespace* in general; see *Visualizing Whitespace*.

[97] The magic of 80 characters or columns was a holdover from the days of the punched card, which in turn led to computer terminals with screens that measured 80 columns wide.

is in fact an entire paragraph, and paragraphs therefore no longer even need to be separated by blank lines (though they may be). This convention arose with GUI applications, whose windows weren't limited to 80 column lines and whose widths could be resized at will: single-line paragraphs auto-fill as the screen is resized, but multi-line paragraphs do not. Emacs of course supports this convention but it's not the default, primarily because Emacs was written by and for programmers, and both computer programs and computer data files are typically expressed as lines with explicit newlines, and the lines may have semantic significance.

For details on how long lines are displayed and what you can do to change it, see *The Display of Lines*.

What Isn't *Text?*

There's no law that says text can't include non-printing characters, like, say, a `C-a` (which is ASCII 1 decimal). If a file contains only printing characters, it clearly deserves the label "text"; if it contains *none*, it clearly doesn't and instead we call it *binary data*. But in between, the label is a judgment call. Regardless, Emacs needs to show you non-printing characters when they occur.

(I'm afraid this section has to be very nerdy; none of this will surprise a programmer, but the explanation of it all involves the distant history of computing, computing Standards (gulp), and a variety of number bases. Feel free to skip ahead!)

When one of the ASCII *control characters*—those in the range decimal 0–31[98]—occurs in a Buffer, Emacs displays it specially, using the traditional programmer's notation for control characters: a circumflex followed by an uppercase letter (or punctuation mark in six cases), for example `^A`, which is the same character that Emacs refers to as `C-a`. Table 5 shows these in the "Control" column.

Thus, in your Buffer, a single control character displays as a pair of characters. This is ambiguous: is that `^A` one character, ASCII decimal 1 aka `SOH`, or is it the two *printing* characters, `^` followed by `A`? There are two ways tell:

1. by movement: your cursor will skip over a control character with a single `C-f` (`forward-char`), where it would take two `C-f`'s to move over the pair of printing characters;

2. by color: the control characters are colored differently than the printing characters; if your Buffer text is black-on-white, the control characters will be *red* e.g. `^A`; if your Buffer text is white-on-black[99], the control characters will be *cyan* e.g. `^A`.

[98] There's also the rogue control character, `DEL` (ASCII 127 decimal), at the end of the ASCII table. Sorry about that!

[99] As from starting up Emacs with the `-rv` or `--reverse-video` option, or having chosen a dark theme.

Dec	Hex	ASCII	Control	Dec	Hex	ASCII	Control
0	00	NUL	^@	16	10	DLE	^P
1	01	SOH	^A	17	11	DC1	^Q
2	02	STX	^B	18	12	DC2	^R
3	03	ETX	^C	19	13	DC3	^S
4	04	EOT	^D	20	14	DC4	^T
5	05	ENQ	^E	21	15	NAK	^U
6	06	ACK	^F	22	16	SYN	^V
7	07	BEL	^G	23	17	ETB	^W
8	08	BS	^H	24	18	CAN	^X
9	09	HT	^I	25	19	EM	^Y
10	0A	LF	^J	26	1A	SUB	^Z
11	0B	VT	^K	27	1B	ESC	^[
12	0C	FF	^L	28	1C	FS	^\
13	0D	CR	^M	29	1D	GS	^]
14	0E	SO	^N	30	1E	RS	^^
15	0F	SI	^O	31	1F	US	^_

Table 5: ASCII Control Characters, Excepting Delete

There are other characters, which are tricky to classify as printing or non-printing, that aren't part of the original ASCII character set: they would occupy the slots from 128–255 decimal in an expanded table. If these characters appear in a Buffer (one using the `binary` Coding System), they are represented as a backslash followed by a three-digit number e.g. `\304`.[100] Again, your cursor will move over such a character in one step, and they're colored the same as the control characters.

[100] I'm sorry to report that these are Octal (i.e. base-8) digits; you'll just have to trust me that there was a good historical reason for this choice.

Inserting Non-Printing Characters

If you're curious and want to see some of these non-printing characters in a Buffer, you can just visit a native-code executable file on your computer.[101] But what if you need to insert one? Obviously you can't insert a `^A` by typing `C-a`—that will just move your cursor to the beginning of the line!

[101] On a Unix system, try `C-x C-r /bin/date`.

The basic command for this is `C-q` (`quoted-insert`). Inserting a control character is easy: to insert a `^A`, just type `C-q C-a`. You can also needlessly quote printing characters—say, `C-q A`—which just inserts the printing character normally.

What if you want to insert "international", non-Latin, characters from Unicode, or you want to type fancy glyphs like Æ, or ¶? See *International Character Set Support* for details.

Buffers

> Just as in Unix "everything is a file", in Emacs "everything is a buffer". [...] In most [...] editors (and most other applications, for that matter), we have things such as dialog windows, non-editable text areas [...], file-selecting widgets, etc. Not in Emacs: here, all these are buffers. — Marcin Borkowski, "TEXing in Emacs"

A Buffer is a very complex data structure. Most importantly a Buffer contains text, but additionally each Buffer keeps track of various locations (where you are now and where you've been recently) and parameters (like how much to indent lines), maintains an Undo history, has a Major Mode that customizes commands run in the Buffer to work distinctively on the type of text it contains, may have several Minor Modes to further tweak behavior to your taste, and has a set of key bindings that may be different from those in other Buffers. If it's visiting a file, the Buffer keeps track of its state compared to the file on disk.[102]

[102] I'm using the term *data structure* loosely here, from the perspective of the Emacs user, not the programmer; really, most of these features of buffers are composed of sets of buffer-local variables.

In this chapter we're mostly going to talk about Buffers as abstract objects—black boxes—as distinct from what they contain. The text in the Buffer is much more than just a sequence of alphanumeric characters; how it is entered and displayed is the subject of its own chapter.

The maximum Buffer size is plenty big enough for most purposes: 2,305,843,009,213,693,951 bytes; that's about 2.3 exabytes. Practically speaking, the real limit is the amount of memory available on your system for Emacs to use.

Switching Buffers

To *switch Buffers* means, specifically, to change which Buffer is displayed in a given Window. The basic command to do this is `C-x b` (`switch-to-buffer`); it displays a different Buffer in the current Window, prompting for the new Buffer by name, using Completion. You can also use one of these variant versions:

`C-x 4 b` (`switch-to-buffer-other-window`) Switch to a different Buffer not in *this* Window, but in the "other" Window.[103]

[103] The "other" window is the window that `C-x o` (`other-window`) would switch to; see *Switching Windows*.

`C-x 5 b` *(`switch-to-buffer-other-frame`)* Switch to a different Buffer not in *this* Frame, but in another Frame; if the Buffer is already displayed in a Window in another Frame, switch to that Frame and Window; if not, a brand new Frame is created and the Buffer is displayed in the Window in that Frame.

You can also switch quickly to Buffers you've recently used without specifying their names. Emacs maintains its list of Buffers in a ring in recency order.

`C-x <C-left>` *(`previous-buffer`)* switch to the previous Buffer you were in (in this Frame); repeating this command goes further back in the Buffer-recency timeline

`C-x <C-right>` *(`next-buffer`)* the same, but go forward in timeline order.

(You can also use the less felicitous bindings `C-x <left>` and `C-x <right>`.)

The User Option `switch-to-prev-buffer-skip` allows you to customize which Buffers these two commands consider to be candidates.

The Global Mark Ring provides another way of switching Buffers: `C-x C-SPC` (`pop-global-mark`) will jump to previous Mark locations in other Buffers.

The Tab Line

Outside of Emacs, *Tabs* (not to be confused with the ASCII TAB character nor with tab stops) are a pervasive graphical user interface design element for navigating between multiple "objects" in an application: whether web pages, word processor documents, desktop windows, or whatever. The objects being the subject matter of the application, they would correspond to Buffers in Emacs. Yet Emacs hasn't had Tabs until quite recently[104]: Completion and the Buffer Menus have sufficed for Emacs users for decades.

But now you can turn on the *Tab Line*. The Tab Line is a per-Window construct: a special sticky line of tabs at the top of your Window, each tab shows the name of a Buffer that has been displayed in this particular Window.[105] There's also a +-sign at the right that, when clicked, pops up a classified GUI menu that allows you to switch to any other Buffer, thus adding another tab to the bar.

This is obviously a feature for mouse users, but if you're a keyboard-only person like me, I suppose you might still want the Tab Line for its visuals. Note that the Buffers shown in the Tab Line are the same ones you can navigate through with `C-x <C-left>` (`previous-buffer`) and `C-x <C-right>` (`next-buffer`).

[104] Somewhat confusingly, it suddenly has two kinds of Tabs; see also the Tab Bar.

[105] You can customize which buffers are displayed in the Tab Line, perhaps, say, limiting them to a certain Major Mode.

You can turn the Tab Line on for any Window with `M-x tab-line-mode`. If you want this for all your Windows, say `M-x global-tab-line-mode`; you can make this your default by adding this to your Init File:

```
(global-tab-line-mode +1)
```

The Package Manager is full of third-party packages for selecting Buffers; pretty much any approach any other program or operating system has used for something similar can be found as an Emacs package: from a very visual Mac OS Exposé-like switcher, to my favorite, the very abstract `buffer-stack`.

Creating Buffers

Buffers are typically created for you, implicitly, by any number of commands: the file visiting commands, of course, but also by many of the thousands of other commands: the Help commands create `*Help*` Buffers, for example, and any of the Emacs "applications" like the File Manager (Dired) or the Web Browser (Eww) create Buffers to present their user interfaces. Buffers are used for almost everything in Emacs, and you won't even be aware of most of them; I have 175 in my Emacs as I write this.

You can also just create a new Buffer anytime you want. The command for this is good old `C-x b` (`switch-to-buffer`); typically, this command is used to display a different, existing, Buffer in the current Window, as described in the previous section. But when `switch-to-buffer` prompts you for the Buffer name, if you enter a new, non-existent, one, it instead creates a brand new, empty, Buffer. This Buffer will be in `fundamental-mode` unless your chosen name looks like a filename with an extension (say, `foo.org`), in which case the Major Mode will be determined as described in *How a Mode Happens to Your File*. Regardless, there will be no file associated with this new Buffer.

To Save or Not to Save

When you exit, Emacs will offer to save modified Buffers that are visiting files, so that you don't lose your work. But non-file Buffers don't get this treatment, no matter how much work you may have done in them![106] You can always use `C-x C-w` (`write-file`) to associate a file with such a Buffer after the fact.

It may be tempting to create new non-file Buffers or use the `*scratch*` Buffer just to take some transient notes, but such notes have a way of surreptitiously becoming *important*, and you will lose

[106] Of course, Emacs lets you change this default! See `save-some-buffers-default-predicate`.

them if you exit without saving them somewhere. Emacs has better ways for you to take notes.

Buffer Names

This inspires me to mention the fact that *every Buffer has a name*. There are no anonymous Buffers. Not only must every Buffer have a name, but that name must also be *unique*. When there are natural name conflicts, Emacs will usually disambiguate the newer Buffer name for you. Buffers that aren't visiting a file typically get numeric suffixes, like `*shell*<2>` and `*shell*<3>`, but for files things are more interesting.

The name of a Buffer that's visiting a file is typically the basename of that file; for example, if you visit `/etc/passwd`, the Buffer will be named `passwd`. Since there could be any number of files named `passwd` in various directories, in order for you to be able to visit more than one of them, Emacs must *uniquify* the Buffer name. You can choose from a variety of uniquification algorithms. Using the default algorithm, if you visit `/tmp/passwd`, having already visited `/etc/passwd`, the new Buffer will be named `passwd</tmp>`. See "Uniquify" in the *Emacs* manual for details.

You can rename Buffers at will with `C-x x r` (`rename-buffer`). Since some applications manage their Buffers by name, renaming them might break the app! But many, probably most, Buffers are perfectly safe to rename. While uncommon, you can rename any file-visiting Buffer; the Buffer name won't affect the filename. It's quite common to rename the Buffers of commands that re-use the same name. Although `help-mode` has commands to navigate back and forth through your history of Help invocations, you might want to rename a given `*Help*` Buffer to keep it around and easily accessible.

`M-x shell` is the opposite: when you run it, if a Buffer name `*shell*` already exists, it simply switches to it (kind of like `C-x C-f` (`find-file`); if you want a second shell, you can first rename the existing Shell Buffer to whatever you like.[107] `M-x rename-uniquely` will automatically rename any Buffer for you, using a numeric suffix.

[107] Or you can invoke `M-x shell` with a prefix argument and it will prompt for the new name.

Asterisks

It's conventional that non-file-visiting Buffers created by Emacs commands are named with `*asterisks*`; for example, the Help commands use (and reuse) the Buffer name `*Help*`, and Emacs starts up with a `*scratch*` Buffer. When explicitly creating your own Buffers, you can observe this convention or not, as you like.

Hidden Buffers

Unix users are familiar with the utility of *dot files*: any file basename that begins with a period is by default excluded from the directory listing of the `ls(1)` command. This reduces clutter in a directory listing from files that are always present (like `.` and `..` in any directory, or configuration files like `.bashrc` in a home directory). Of course, you can see these "hidden" files when you need to (by passing the `-a` option to `ls`, for example).

The same concept applies to Buffer names. Many Emacs applications that present themselves via a Buffer, such as the document viewer Doc View or the web browser Eww, use hidden Buffers to manage their state. A hidden Buffer is any Buffer whose name begins with a space character, and by default, they are not offered for completion nor listed by the Buffer listing commands. Hidden Buffers are mainly created by Elisp programmers and you probably don't want to use Buffer names that begin with a space for your own purposes. They're not really suitable for interactive use; in particular, Undo is turned off by default in such Buffers.

The Default Directory

In addition to a name, every Buffer has a *default directory*. This is analogous to the working directory of a process in Unix. The default directory of a file-visiting Buffer is the directory where the file was located. If you're in a shell in a terminal, and you give a filename to some command via a *relative path*, that filename is interpreted relative to the shell's current working directory: Emacs works the same way. If a command prompts you for a filename, the prompt will be preset to contain the Buffer's default directory; you can delete or edit it to name a file in some other directory, of course, but if you completely delete any directory and just enter a relative path, it will be taken as relative to the default directory.

If you create a non-file Buffer, its default directory will generally be inherited from the Buffer you were in when you created it. But any Emacs command that creates a Buffer is free to set its default directory to whatever is appropriate.

The default directory is just a buffer-local variable named `default-directory`. You can check what it is with `M-x pwd`, which prints the value of this variable in the Echo Area,[108] and you can change a Buffer's default directory with `M-x cd`, which sets the variable to whatever directory you specify. Note that changing the default directory of a file-visiting Buffer does *not* change the directory of the file you're editing—not even if you re-save the Buffer. It only affects

[108] You could also say `C-h v default-directory`.

prompt defaults and the resolution of relative pathnames you give to commands while you're in that Buffer. To change the directory of a file you're editing, use `M-x rename-visited-file` or `C-x C-w` (which is equivalent to making a new copy of the file).

Reverting Buffers

File-visiting Buffers can be *reverted* with `M-x revert-buffer` or `C-x x g` (`revert-buffer-quick`) to make the text in the Buffer match the text in its file. There are two major reasons for doing this: either to throw away all the unsaved modifications you've made without undergoing a tedious sequence of Undos (thus restoring the Buffer's text to what's in the file), or because the file has been changed behind Emacs's back by some other process and you want the Buffer to reflect this. See *Files: Reverting Buffers*, *Auto-Reverting (Watching Files)*, and *Files Modified Behind Emacs's Back* for more information.

Many non-file Buffers implementing Emacs applications can also be reverted; the exact meaning of "revert" in these Buffers depends on the application. For example, `C-x C-b` (`list-buffers`) pops up a Buffer containing a list of all your Buffers (see *Buffer Menus*), but if a new Buffer is created later, the list won't (for good reasons, IMHO[109]) be automatically updated to show it; reverting the Buffer will do so. In Major Modes descended from Special Mode, the key `g` is often bound to `revert-buffer`, but check with `C-h m` (`describe-mode`) first.

[109] One usually doesn't want a buffer like this changing on the fly while you might be trying to do something in it; it's at least distracting and might lead to mistakes. Nonetheless, EIPNIF: you can have this if you want it by saying `M-x auto-revert-mode`.

Killing Buffers

There are many ways to delete or, as we say in Emacs, *kill* Buffers, but why would you want to? There are two main reasons:

- Each Buffer takes up in memory at least as much space as the file takes up on disk; when you kill a Buffer, you free up that space and Emacs has that much more to work with.[110]
- Lots of old Buffers means clutter: more Buffers to ignore in Buffer listings, more to ignore when doing Buffer-name completion, more Buffers to search through if you ask Emacs to do so. If you run Emacs as a long-running process in Server Mode (as I recommend), you might accumulate many Buffers over the space of weeks or even months![111]

[110] Actually, Emacs will return that memory to the operating system, so even other processes benefit.

[111] During the pandemic of 2020, I used the Emacs on my desktop at work from home, via `emacsclient` over `ssh`, and when I finally rebooted my desktop, that Emacs had been up for 204 days, 2 hours, 48 minutes, and 55 seconds (according to `M-x emacs-uptime`).

We've already seen the basic command for killing a single Buffer, by name and with completion: `C-x k` (`kill-buffer`); `C-x 4 0` (`kill-buffer-and-window`) kills the *current* Buffer and also deletes the Window that was displaying it; it's especially useful when popping up

hits from a Grep command. There are also several commands to clean up unneeded Buffers:

M-x kill-some-buffers asks whether or not to kill each Buffer in your Emacs; it makes it clear whether or not the Buffer is modified. This command is way too tedious unless you have hardly any Buffers, and if you have a lot, a sort of *highway hypnosis* can set in that might result in you killing a Buffer you didn't want to.

M-x kill-matching-buffers This command prompts for a Regular Expression and only asks about the Buffers whose names match it, so this might be a little bit better.

M-x clean-buffer-list is a totally automatic way to clean up a lot of Buffers, with no prompting and no questions asked. It will of course never kill a modified Buffer, but it will instantly get rid of Buffers that you haven't looked at in a while (by default, 3 days). It's highly customizable, so you can define certain Buffers that it should never clean up; examine `M-x customize-group RET midnight RET`. See also *Midnight Mode*.

I think the best thoughtful (i.e. not totally automatic) way of cleaning up Buffers is via one of the Buffer Menu commands below, which give you a Dired-like interface to the task.

Buffer Menus

`C-x <C-left>` (`previous-buffer`) and `C-x <C-right>` (`next-buffer`), along with `C-x b` (`switch-to-buffer`) (coupled with a good Completion framework) will form the vanguard of your Buffer navigation. But sometimes you'll need a way to get an overview of all your Buffers, and some tools to manage them. This is what the *Buffer Menus* provide. A Buffer Menu is to Buffers what Dired is to files.

There are three main choices: `list-buffers`, `bs-show`, and `ibuffer`.

The most basic command is `C-x C-b` (`list-buffers`); it pops up a `*Buffer List*` Buffer that lists all the Buffers in your emacs, giving, along with their names, their sizes, Major Modes, and visited file name (if any):

```
CRM Buffer         Size  Mode              File
.%  passwd          1699 Conf[Colon]      /etc/passwd
 %  *Calendar*       531 Calendar
 %  *Help*           554 Help
    *scratch*        145 Lisp Interaction
 %* *Messages*       305 Messages
```

The cryptic CRM Column shows the current Buffer (indicated by a period in the C column), a % under R if the Buffer is read-only, and a * under M if the Buffer is modified.

This Buffer is in buffer-menu-mode, and if you switch into it, a number of Buffer-management commands are available. Just move to anywhere within a Buffer's line and the special commands will operate on that Buffer. Some operate immediately, but some only mark the Buffers and perform the operation when indicated. See table 6.

Table 6: buffer-menu-mode Commands

Key	Action
RET	replace Buffer Menu with this buffer
1	like RET C-x 1
o	select buffer in Other window
V	... in view-mode.
C-o	display buffer in Other window (without switching)
m	mark this buffer for v or M-s a ...
v	display this and all marked buffers
u	remove all marks from this line
DEL	back up a line and remove marks
U	remove all marks in the Buffer Menu
M-DEL	remove a particular mark from all lines
T	Toggle display of only file buffers
S	Sort lines by the column that contains Point
{	narrow this column
}	widen this column
b	Bury the buffer listed on this line
t	visit Tags table of this buffer
~	clear modified-flag
%	make buffer read-only
s	mark for Save upon x
C-k	mark for Kill upon x, move down
C-d	mark for kill upon x, move up
x	eXecute kill or save marks
M-s a C-s	Incremental Search in the marked buffers
M-s a C-M-s	Isearch for regexp in the marked buffers
M-s a C-o	Occur in the marked buffers
g	revert (update) the Buffer Menu
q	hide the Buffer Menu

bs-show is very similar to list-buffers; it has a very similar command set[112], but is more customizable and, in its default configuration, is a bit more colorful. I'd recommend it over list-buffers just for that reason; you can bind it to C-x C-b with:

[112] Just different enough to be annoying!

```
(keymap-global-set "C-x C-b" 'bs-show)
```

The Buffer Menu that I use is `ibuffer`. It's even more colorful than `bs-show`, but it has the largest command set and is more like Dired than the other two.[113] It has a more extensive set of marking commands, a much larger, stackable, set of commands to filter the Buffer Menu (e.g., by Major Mode, by visited directory name, by size), and a much larger set of sorting commands. It has so many commands that I won't attempt to summarize them here; say `C-h f ibuffer-mode`.

[113] Though the key bindings are annoyingly dissimilar; I've long intended to sit down and make Ibuffer's bindings as close to Dired's as possible…

I recommend it, and I bind it to `C-x C-b` with:

```
(keymap-global-set "C-x C-b" 'ibuffer)
```

Note that neither `list-buffers` nor `bs-show` will list hidden Buffers (those starting with a space). `ibuffer` can do this, however.

Narrowing

Many commands that perform repetitive operations (like Query Replace) will limit their operation to the active region. Some (like Keyboard Macros) do not, but these recalcitrant commands can be convinced to do so by *narrowing* the Buffer to the Region (whether active or not). `C-x n n` (`narrow-to-region`) hides the parts of the Buffer outside the region, making them almost completely inaccessible. After narrowing, you can run any command on the entire Buffer without worrying that it will affect the hidden parts. Narrowing can also be useful just to focus your attention on a part of your text, say a particular paragraph, or a gnarly function, with no distractions.

Once you've narrowed, it's as if the rest of the Buffer is gone. The Buffer size indicator in the Mode Line will report the size of the narrowed portion as if it's the entire Buffer, and any displayed line numbers will be reset from 1. If you save a narrowed file-visiting Buffer, you will *always* save the entire Buffer, including the invisible parts—don't worry that you might lose data by saving only the narrowed part to the file!

The Mode Line will include the word "Narrow" in the parenthesized list of Minor Modes (even though narrowing isn't, strictly speaking, a Minor Mode). There *are* a few other giveaways. The value of Point, which you'll recall is the offset, in characters, from the beginning of the Buffer, remains relative to the entire unnarrowed Buffer. One command that reveals the value of Point is `C-x =` (`what-cursor-position`). Suppose you narrow your 500K Buffer to one paragraph in the middle of the text; `what-cursor-position` will show that Point is something like 254,120 rather than 1. Go ahead and try it!

But wait, first I'd better tell you how to restore your Buffer after narrowing it! `C-x n w` (`widen`) does the job. Point remains where it was, and all the hidden parts blossom forth again.

If someone new to Emacs accidentally narrows a Buffer, the usual assumption is that, somehow, much text has mysteriously been lost, and the reaction is dismay. For this reason, `C-x n n` (`narrow-to-region`) is *disabled* by default. But it's a very useful command, and I recommend you enable it after you've tried it a couple of times.

Modes, Major and Minor

	Major Mode	Minor Modes
Specialization	**X**	
Preferences		**X**

The main way Emacs specializes different kinds of text — prose, programming languages, data file formats — is through *Major Modes*. Major Modes typically provide customized fonts, colors, and other styling; layout (indentation and such); key bindings; templating; integration with compilers, interpreters, and debuggers; and more.

Every Buffer *always* has a single Major Mode, and may have zero or more *Minor Modes* enabled. While Major Modes implement broad sets of features suited to a particular kind of text or Emacs application (an application like, say, a web browser), Minor Modes are typically independent of any particular kind of text, and instead implement user preferences and features that are generic and could enhance many or all Major Modes: things like spell check, line numbers, or folding text.

The Major Mode is, by default, shown in the Mode Line as the first word in parentheses. If your Buffer is in `python-mode`, the Mode Line will show:

```
(Python)
```

(the Major Mode indicator may be followed by a list of space-separated Minor Mode indicators).

Many Major Modes are for particular programming languages, but they also exist for markup languages (TEX and LATEX, Troff, HTML, Markdown, Org), config file formats (for INI files, and many application-specific formats like Apache, Git, Kubernetes, etc), data file formats (Json, CSV, XML, Turtle (RDF), YAML, BibTex), image files, PDF files, and more.

An important role for Major Modes is to implement interfaces to external programs, like version control systems (Git, Mercurial, etc), databases, shells, Grep, and programming language REPLs; more Modes implement 100%-Emacs applications like file managers, email systems, games, and web browsers.

At the moment, there are at least 478 more Major Modes available in the Package Manager, and even more on Github and the like. Basically, if you're editing some kind of structured text, there's an Emacs Mode to make the editing better.

How a Mode Happens to Your File

When you visit a file, Emacs chooses a Major Mode for you automatically, typically based on a file extension. Files ending in `.org` will automatically be in `org-mode`; files ending in `.py` will automatically be in `python-mode`.

But Major Mode selection is really more complex. Emacs has a decision tree that proceeds from the file contents, through the file name, to your chosen overall default. Here's the complete sequence.

Mode via File-Local Variable

You can explicitly set the Major Mode by including a string like this:

```
-*- MODE -*-
```

somewhere on the first non-blank line of the file, where `MODE` is the name of the Mode, leaving off the trailing `-mode`. So this line:

```
-*- python -*-
```

will cause Emacs to choose `python-mode` when it visits the file. Likewise:

```
-*- emacs-lisp -*-
```

selects `emacs-lisp-mode`.

The Mode string can be preceded on its line by any text, and followed by even more text. This allows you to put the Mode string in a comment; thus:

```
/* -*- c -*- */
```

selects `c-mode` and

```
# -*- python -*-
```

selects `python-mode`.

File local variables, in their full glory, are a concept originated by Emacs.[114] You can set additional variables this way:

[114] Dating from 1992 or earlier.

```
-*- python; python-indent: 4 -*-
```

and you can also set them at the end of the file, if your language is particular about the top, or if you just prefer them there (they might be less distracting).

Mode via Shebang, or Interpreter Directive

If the Major Mode wasn't chosen due to a file-local variable, Emacs next looks to see if the file begins with a *shebang*, or interpreter directive. This is a Unix concept that allows executable text files to be run as scripts by a variety of programming language interpreters. So if your file begins with: `#!/bin/sh` Emacs will select `shell-script-mode`. By default, Emacs knows how to map 44 interpreter names to the right Major Mode; you can customize the variable `interpreter-mode-alist` to tweak these choices or add more.

Unix says that the shebang *must* be the first line of a file, so if you also want some file-local variables, you'll need to set them via the end-of-file syntax.

Mode via Filename

If the Major Mode was chosen neither by a file-local variable nor a shebang, Emacs next checks to see if the file extension determines the Mode.[115] This is controlled by the variable `auto-mode-alist`, so you can override the defaults to suit your preference. Out of the box, `auto-mode-alist` encodes over 200 different file extension / Mode pairings.

This variable actually allows more sophisticated choices than just the file extension: you can base the choice on the structure of the entire file name, including the directory (so you can set a default Mode for all the files in a given directory, regardless of their basenames or extensions), and (as is typically the case in such customizations) you can even base the choice on the result of a function call.

[115] Actually, the next step is to see if the file has a *magic number*. (This is the way the Unix `file(1)` command identifies files.) There are currently no magic numbers defined in Emacs by default; you can add your own to `magic-mode-alist`. But see the related Magic Fallback.

Mode via Magic Fallback

If the Major Mode has *still* not been chosen, Emacs now checks `magic-fallback-mode-alist`, which examines the content of the file to determine the Mode. This default value of this variable contains patterns and functions that recognize image formats and make distinctions about HTML and XML file formats (which can't easily be made via file extension).

The Last Resort

Finally, if the Major Mode remains undetermined after this entire process, the *default value* of the variable `major-mode` is used. The *default* default (!) is `fundamental-mode`, the ultra-minimal Major Mode that does absolutely nothing special.

You can change the default Major Mode to something else, like for example:

```
(setq-default major-mode 'text-mode)
```

after which you'll get `text-mode` as your default. (If you're a programmer or system administrator — one who edits system files — I highly recommend keeping `fundamental-mode` as the default value of `major-mode`; any other choice might result in surprising changes to a file when you save it, without your noticing.[116])

But really there's one final, ultimate, decision: in the case that `major-mode`'s default value is `nil`, which will only be the case if you choose to make it so, the Major Mode will be that of the Buffer you were in before you switched to a new Buffer (by visiting a file, or creating a new Buffer say by giving `C-x b` (`switch-to-buffer`) a nonexistent Buffer name).

[116] Typically, changing spaces to tabs or vice versa.

Setting the Mode Explicitly

You can always set the Major Mode of a Buffer explicitly, either because the usual process came up with `fundamental-mode`, or chose the wrong Mode (perhaps due to an unusual or nonexistent file extension), or just because you prefer an alternative Mode at the moment.

Conventionally, Major Modes exist as commands named according to the pattern *major-mode-name*-mode, so you can switch to Org Mode by invoking `M-x org-mode` or to Emacs Lisp Mode with `M-x emacs-lisp-mode`. After switching, there might be a visual change as the new Mode's syntax colorization takes effect; for example, after switching to `fundamental-mode`, any colorization will disappear, since `fundamental-mode` doesn't do any syntax highlighting (this is one of the most common manual Mode changes, because since `fundamental-mode` does nothing visually to the characters in the file, you can be sure you're seeing the precise contents).

To restore Emacs's choice of Mode, you could reinvoke the Mode's function by name, but the simplest way is to say `M-x normal-mode`. `normal-mode` is not a Major Mode, but rather just a Command that instructs Emacs to go through the entire Major Mode-choosing process again.

Help for Your Mode

If you want to know what's up with the Major Mode Emacs has chosen, just say `C-h m` (`describe-mode`). The `*Help*` Buffer will first list all the enabled *Minor* Modes (because Major Modes often turn on

a set of Minor Modes); these are hyperlinked to complete descriptions later in the Buffer. Then the documentation for the Major Mode will be presented (for some Modes, this is quite extensive), and then typically a complete list of Major Mode-specific key bindings will be given (there might only be a couple; for some Modes, like `org-mode`, there might be several hundred!). Finally the documentation and key bindings for all the Minor Modes will be given. This can be a lot of documentation; for me, the Org Mode `*Help*` Buffer is over 900 lines long!

Customizing Modes

It's very common to want to customize the way a Major Mode[117] works, and well-written Major Modes (the majority of them!) provide many ways to do so. You might want to change the default indentation level or the color of comments or string literals in a programming language Mode. You might want to change some of its key bindings to ones that are more mnemonic or easier to type. You might want to disable an annoying command that you find yourself accidentally invoking (I do a lot of this!).

[117] Or a Minor Mode; the principles are the same.

The simplest type of customization is to modify the value of a *user option*, i.e. an Emacs variable that's explicitly intended to be used to tweak a Mode's behavior. The easiest way to do this is to go to a Buffer that has the Major Mode you're wanting to tweak and invoke `M-x customize-mode`; this gathers all of the Mode's user options together and you can use the Customize facility to change them. You can also just set these options in your Init File via Elisp, e.g.:

```
(setq python-indent-offset 2)
```

see *User Options*. How do you find out what user options exist to be customized? Browsing the `customize-mode` Buffer is a good way; you can also use `M-x apropos-user-option` with a query like `python indent`, and don't forget to read the Info manual for Modes which have one.

Customize doesn't give you a way to change key bindings, so you'll need to hack your Init File to do that! See *Modifying Key Bindings* for instructions.

Finally, you may want to customize a Mode in a manner that never occurred to the programmer who wrote the Mode, and so there's no handy user variable to tweak. A common desire is to turn on several specific Minor Modes whenever you're in a given Major Mode: for example, spell checking. But that's just one of any number of possible Minor Modes. The programmer of the *Foo* Major Mode shouldn't

try to provide user options like `foo-enable-spellcheck` because even though spell checking is a common desire, there's more than one way the user might want to do it, and more to the point, there is an unlimited number of extant and not-yet-written potential Minor Modes of interest. And you may want to enable a behavior that's not even a formal Minor Mode[118].

[118] Perhaps you want to play a special sound every time you enable a given mode... Who knows what you might want to do!

Fortunately, Emacs has a general purpose mechanism to solve this problem; it's pervasive and part of what makes Emacs so malleable: *Hooks*. Hooks exist to provide a way for an action of some kind to also perform some other arbitrary actions at your behest. Every Major and Minor Mode `FOO-mode` respects a variable `FOO-mode-hook` which is intended to contain a list of functions. Each function in this list is executed, in order, after the Mode is done initializing the Buffer. You simply add functions to this list; the functions can do whatever you want.

So, if you want spell checking in Org Mode, and you prefer `flyspell-mode` to `ispell-minor-mode`, you can add this line to your Init File:

```
(add-hook 'org-mode-hook 'flyspell-mode)
```

If you don't generally want line numbers turned on, but you *do* want them in `python-mode`, add this line:

```
(add-hook 'python-mode-hook 'display-line-numbers-mode)
```

As the name implies, the `add-hook` function adds an additional function to a hook variable, at the front of the list. `add-hook` is clever and only adds the function if it isn't already present (that way it doesn't run twice).

`flyspell-mode` and `display-line-numbers-mode` are both Minor Modes, and Minor Modes are designed to be easy to add to hooks. But you can add arbitrary functions as long as they make sense. Want to give yourself a little encouragement whenever you open an Elisp Buffer?

```
(add-hook 'emacs-lisp-mode-hook
  (lambda () (message "Don't fear the parentheses!")))
```

More complex Modes will define more than just the default after-Mode-initialization hook, and will run these hooks when certain actions occur. `org-mode`, for example, an especially complex Major Mode, has 90 hooks.

Hooks are not really just for Modes. There are many defined for Emacs actions that occur "globally" — hooks for when Emacs starts up and when it exits, for example — and individual functions defined outside of any major Mode can have their own hooks so that users can customize their behavior.

Derived Modes and Inheritance

Almost all Major Modes are derived from some preexisting Mode that's in some way similar. This way, the new Mode inherits behavior from the parent (which may have inherited behavior from *its* parent, and so on). The new Mode inherits the parent's keybindings, syntax table, abbreviations, and Major Mode hook, and can then change anything it's inherited, or not. Note that the new Mode's hook will run *after* all the inherited Mode hooks. So if someone invents a new variant of the Lisp programming language, say "Neolisp", a new Emacs `neolisp-mode` might well be derived from `lisp-mode`.

There are five Major Modes that are commonly used as parent Modes: `text-mode`, for a new Mode that deals with something similar to natural-language prose; `prog-mode`, for new programming language Modes; `special-mode`, for Modes that let you view data more than they let you edit it (this includes most applications); `tabulated-list-mode`, for Modes that present a view of data in sortable columns (and which is itself derived from `special-mode`); and finally, `fundamental-mode`, the most minimal Mode of all. Note that `prog-mode`, `special-mode`, and `tabulated-list-mode` exist only to be derived from, whereas `text-mode` and `fundamental-mode` are themselves often used as Major Modes.

Basic Major Modes

Here are a few basic Major Modes that can be useful when Emacs doesn't have a better idea for your text.

`fundamental-mode`

This is the basic Mode in reference to which many other Modes are defined. It's perfectly fine for editing any kind of text, it just doesn't provide any special features: it has no Mode-specific key bindings and no colors to distinguish different kinds of text. Every character in the Buffer looks exactly like itself.

It's occasionally useful to turn off the fancy features of a specialized Mode by switching a Buffer into `fundamental-mode`; see *Setting the Mode Explicitly*.

`text-mode`

For editing plain, unspecialized, natural language prose, i.e. blank-line separated paragraphs consisting of sentences. This is the Mode Agatha Christie would have used for her books, if she'd had Emacs instead of her typewriter. Quite minimal.

outline-mode

You can add a little more structure to your prose by using `outline-mode` (see "Outline Mode" in the *Emacs* manual). Lines that start with an asterisk form the nested headlines of an outline, and you can fold (hide) and unfold the text of the outline levels, easily reorder them without cutting and pasting, etc.

```
* My Header
Some text.
** A Nested Sub-Header
* Next Header
```

In recent years, `outline-mode` has been largely subsumed under Org Mode, which includes all its features, with friendlier key bindings, and adds so much more. In my opinion you should skip over `outline-mode` and go direct to Org.

Programming Language Modes

As of version 29.4, Emacs ships with Major Modes for at least Ada, Assembly Language, AWK, C, C++, Common Lisp, Emacs Lisp, Fortran, Icon, Java, Javascript, M4, Makefiles, Metafont, Modula2, Object Pascal, Objective-C, Octave, Pascal, Perl, Pike, PostScript, Prolog, Python, Ruby, Scheme, Shell (Bourne-, C-shell-, and `rc`-derived flavors), Simula, SQL, Tcl, Verilog, and VHDL.

In such a Mode, Emacs does all the sorts of things you expect of an integrated development environment (IDE): syntax highlighting to colorize and fontify the different syntactic elements of the code, specialize textual objects for the language (so Emacs's symbols match the languages identifiers, and its functions match the languages function definitions), balance parentheses, complete identifiers, enable commands to insert and delete comments, indent and dedent the lines appropriately, show documentation of built-in functions, jump from function and identifier uses to their definitions, expand source code templates, send function definitions to the language interpreter (REPL), interact with a debugger, compile code, and jump from compiler error messages to the locations in question.

Some of the common features of IDE's are handled by independent, orthogonal Minor Modes. On-the-fly syntax and style checking (linting) is often handled by Flycheck[119] or for languages that use the Language Server Protocol, Eglot or `lsp-mode`. Spellcheck in comments is handled by `flyspell-prog-mode`. Project navigation is the domain of Projects or the much fancier Projectile. Version control has its own chapter, as do build tools, searching, and debugging.

[119] To be preferred over the older, built-in, Flymake.

Application Modes

Many Major Modes, descended from `special-mode`, exist to implement applications. There are innumerable examples: Dired the file manager; the Grep family; Eww, the web browser; Gnus, the mail user agent; VC, the version control system. The more elaborate applications may really be a complex of several Major Modes; the Gnus "application" consists of 16 Modes. See *Part III: NEVER LEAVE EMACS: APPLICATIONS* for details on many of these.

Minor Modes

Minor Modes work like mix-ins: enable as many as you like. Emacs turns on a dozen by default to implement things like the automatic handling of compressed or encrypted files, and I typically have a couple dozen other Minor Modes enabled too. At the moment, there are at least 161 more Minor Modes available in the Package Manager, and even more on Github and the like.

Minor Modes come in two flavors, *global* and *Buffer Local*, and some come in both. When you turn on a Buffer Local Minor Mode, it's only enabled in the current Buffer; if you want it on in another Buffer too, you need to turn it on there separately. This is why we often add Minor Modes to a Major Mode's startup hook: so that they're automatically turned on in all Buffers in that Major Mode. But Minor Modes that are likely to be generally useful in any Major Mode often come in a global flavor; when you turn on a global Minor Mode, it'll be on in every Buffer that's created. We've seen how you turn on line-numbers in a Buffer with `M-x display-line-numbers-mode`; but there's also `M-x global-display-line-numbers-mode`. It's up to the programmer who implements a Minor Mode to decide whether to provide a global command, a Buffer Local command, or both.

Some Minor Modes will be listed in the parentheses of the Mode Line, after the Major Mode. Right now, my Mode Line shows:

```
(Org Ind Fly PgLn NoMouse! Fill)
```

`org-mode` is the Major Mode and all the rest are Minor Modes. Minor Modes may shorten their Mode Line indicator[120] dramatically ("Ind" above is `org-indent-mode`), and some choose to provide no indicator at all (global ones tend to use no indicator). Minor Modes are used so heavily nowadays they can take up a lot of Mode Line space. Each of these indicators provides various actions for mouse clicks; see the Mode Line chapter.

We've seen how to add Minor Modes to hooks, but you can also

[120] Technically called a "lighter".

turn them on and off manually. Any Minor Mode command, like `M-x flyspell-mode`, will toggle that Mode: if it's currently off, it'll be turned on, and vice versa. (This is different from Major Mode commands, which only turn the Mode on; since there's always one and only one Major Mode in a Buffer, you can't simply turn it off: all you can do is turn on (and thus replace it with) a different one.) Global Minor Modes work the same way, affecting all Buffers. The only practical way to turn on Buffer Local Minor Modes in your Init File is via hooks, but you can directly turn global Modes on in your Init File like, for example:

```
(global-display-line-numbers-mode +1
```

Application Buffers

Broadly speaking, there are two kinds of Buffers in Emacs: those that are visiting files, and those that aren't. In file-visiting Buffers, we are editing (or at least viewing) the contents of a file.

Non-file-visiting Buffers can be loosely subdivided into two further types. The first is *temporary Buffers*. When you ask Emacs to display some information with a command like `M-x list-colors-display` or `M-x list-holidays`, the results are displayed in temporary Buffers. Of course, you can create a brand-new, empty, non-file-visiting Buffer as simply as `C-x b` (`switch-to-buffer`) `NEWNAME`. You might even scribble notes in it, or use it to gather text from other buffers for editing. Such Buffers are transitory and thus unimportant: if one becomes important to you, you save it to a file with `C-x C-s` (`save-buffer`): now it's a file-visiting Buffer.

The second type of non-file-visiting Buffer is what I'll call *Emacs Applications*: Buffers that implement the user interfaces of special purpose programs: Buffers that you *interact* with. Such Applications include file managers, web browsers, shells and terminals, version control programs, mail user agents, games, and much more.

As I write this, my Emacs has 59 non-hidden Buffers, and 34 of them, the majority, are Applications: I would say that proportion is completely typical. Application Buffers are what make Emacs a Lisp Machine: a plain-text computing environment. You could turn that around and say that Application Buffers exist *because* Emacs is a Lisp Machine: the fact that it's so readily programmable has resulted in people using it to create so many Applications.

We've already discussed a few Applications without emphasizing it: the Help, Apropos, and Info subsystems; and the Minibuffer. These Applications, and many more, exist as user interfaces to Emacs itself, but most, as we'll see soon, are Emacs front-ends to your computer, to the network (and the web), and to Unix command-line applications. And some are completely stand-alone Applications, rather than front-ends to anything else (for example: the Calculator, Calendar, and various *Games and Amusements*).

(You can also think of the fancier file-visiting Major Modes as ap-

plications: IDE's for programming languages, document viewers, and the like; in a Lisp Machine, it's really hard to make these distinctions.)

Every Application is unique, but most of them start out inheriting behavior from a Major Mode called `special-mode`. As a result, lots of Applications share a certain amount of behavior and key bindings, which I'll discuss briefly here.

But first and foremost, an Application Buffer is just that: *a Buffer*. Most of what you've learned about Buffers applies to Applications. Of course, there will be differences, but in general in any Application you already know things like:

1. how to navigate within it (use the motion and search commands)
2. how to copy text (or data) from it (just select text and use `M-w` (`kill-ring-save`))
3. how to get help about it (`C-h m` (`describe-mode`))
4. how to switch between Applications (just switch Buffers)
5. how to kill an Application (`C-x k` (`kill-buffer`))

This is one of the advantages of Emacs as a computing environment: you have less to learn because you already know these things.

Application Buffers start out and almost always remain read-only, and inherit the following key bindings from `special-mode` (see Table 7), but remember that any Application will add more bindings, and very often change some of the inherited ones, in the name of usability. Almost all `special-mode` commands are just handy shorthands for commands you already know, shown in the "Also" column.

Table 7: `special-mode` Key Bindings

Key	Also	Action
`SPC`	`C-v`	scroll forward
`DEL`, `S-SPC`	`M-v`	scroll backward
`<`	`M-<`	go to beginning-of-buffer
`>`	`M->`	go to end-of-buffer
`-`	`C-u -`	give next command a negative arg
`0...9`	`C-u 0 ...`	give next command a numeric arg
`?`, `h`	`C-h m`	show help for mode
`g`	`C-x x g`	revert the buffer
`q`	`C-x 0`	hide the Application window

Note that most Applications don't have a command to stop or terminate them; you can just switch away from their Window (`special-mode`'s `q` command is an easy way) and never come back. As usual, if you want to clean up, you can just kill the Application's buffer.

Windows

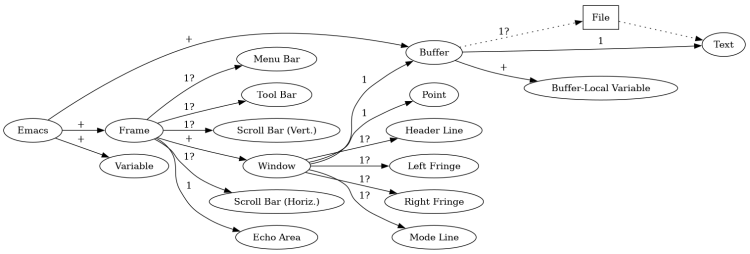


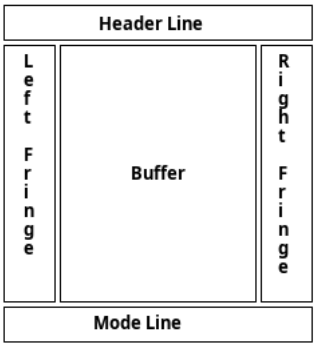
Figure 14: Emacs Data Structures

Legend:

+	One or more
1	Exactly one
1?	One or none

When Emacs starts up, it presents a Frame containing a single *Window*. This Window displays a Buffer, and has its own Point. Optionally, a Window (almost always) has a Mode Line, and (less frequently) any of a Header Line, a left Fringe and a Right Fringe; see Figure 15.

Figure 15: The Parts of a Window



The Frame can be *tiled* into multiple Windows in a rectangular grid; that is, any Window can be recursively subdivided into more Windows, horizontally or vertically; see Figure 16.

At any moment, one Window is the distinguished *selected* Window[121]; most editing commands, including self-inserting commands, take effect in the Buffer of the selected Window.

Different Windows may display the same Buffer[122], and they don't

[121] Note the solid block cursor of the selected window versus the hollow cursors of the the others in Figure 16.

[122] All the windows in Figure 16 are displaying the same buffer.

Figure 16: Tiling Windows

need to display the exact same part of the Buffer: one could display the beginning of the Buffer while another displays the end, and there may or may not be any overlap. If you can see the same part of the Buffer in two Windows, and you modify the text there, you will see the modifications in both Windows. Since each Window has its own Point, you can move and scroll independently in different Windows displaying the same buffer.

Splitting Windows

Since it's impossible to have a Frame with no Windows, there's no command to create a Window out of thin air. If you want a new Window, you have to pick an existing Window; switch to it, if it's not the selected Window; and *split it*. We've already discussed this in *Basic Commands to Manipulate Windows*. The fundamental commands are `C-x 2` (`split-window-below`) and `C-x 3` (`split-window-right`).

There are two new commands that perform a higher-level sort of split that would take a little fiddling to do manually. The both split your current Frame into two equal halves, preserving your complete current window layout in one of the two halves (with its windows scaled down to take up half the Frame), and giving you a new, big, half-Frame-sized window to use as you like. `C-x w 2` (`split-root-window-below`) puts the new big window at the bottom of the Frame (where `C-x 2` would put the new window) and `C-x w 3` (`split-root-window-right`) puts it on the right (where `C-x 3` would put it). I find `C-x w 3` to be the more useful of the two, because fiddling with side-by-side Windows is always trickier.

I know this is hard to picture; just set up two or more Windows in a Frame and say `C-x w 2` and you'll get it immediately; then do `C-x w 3` right after that.

Deleting Windows

There are two basic commands for deleting Windows: `C-x 0` (`delete-window`) and `C-x 1` (`delete-other-windows`): in other words, you either delete *this*, the *selected*, Window, keeping all the rest, or you delete *all* the other Windows, keeping only this one.

`C-x w 0` (`delete-windows-on`) prompts for the name of a buffer and deletes *all* the Windows that happen to be displaying it.

None of these three commands in any way affect the buffer being displayed: in particular, they do *not* kill the buffer.

Switching Windows

To "switch Windows" means to change the selected Window, without necessarily changing the number or layout of the Windows. Mouse users can switch Windows by just clicking anywhere in another one. For those of us that prefer the keyboard, the most basic command to change the selected Window is `C-x o` (`other-window`), which switches to *the Other Window*; repeated invocations cycle through all the Windows in the current Frame.

Which Window is the "other" one? Simple: it's the next Window in a pre-order, depth-first traversal of the Window tree arranged in a cyclic ring! It's a little hard to express in a less-nerdy manner, but if your Window configuration were that in Figure 17, and the selected Window was the Window labeled `S` (for *selected*), then the Other Window is Window `1`, and repeating `C-x o` would cycle through the Windows in numeric order, returning to Window `S` after Window `6`.

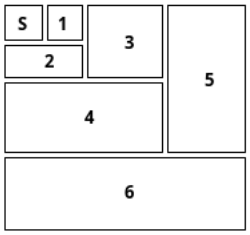


Figure 17: The Mysterious Other Window

`C-x o` is fine when you have only two Windows (a very common configuration), and okay for three, but after that it's frankly kind of

tedious and if you overshoot, you have to circle all the way around again![123]

[123] Well, you can back up by giving `C-x o` a negative prefix argument as with `C-u - C-x o`...

Optional packages to the rescue! I use the `windmove` package, which essentially gives you four new directional versions of `C-x o`: switch to the Window to the right, the left, the one above, and the one below. By default these are on the shifted arrow keys. So in Figure 17, if you're at `S` and want to switch to `5`, you can just say `<S-right> <S-right> <S-right>` (or take another route, like `<S-down> <S-down> <S-right>`) rather than six `C-x o`'s. `windmove` is not so much about minimizing the keystrokes as making them more direct and easy to think about.

Another package that's well-liked is Oleh Krehel's `ace-window`, which gives you one new function, which you would probably bind to `C-x o`; when executed, the Windows all display a transient label in their upper-left-hand corners—by default a digit—and you just type the label of the Window to which you want to switch. That's three keystrokes to switch to any Window, regardless of how many Windows are in your frame. It's also kind of visually sexy.

You can choose between either of these, or use both, or search the Packages for many other possible solutions. Here's a recommended Init File snippet that sets up `windmove`:

Init File

```
(unless (package-installed-p 'windmove)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'windmove)))
;; <S-{left,right,up,down}> switches windows
(with-demoted-errors "%s" (windmove-default-keybindings))
```

If you want `ace-window`, replace or supplement the snippet above with this one; feel free to choose a different keystroke if you want to preserve `C-x o`.

```
(unless (package-installed-p 'ace-window)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'ace-window)))
(keymap-global-set "C-x o" 'ace-window)
```

Finally, there are of course innumerable commands that have the side-effect of switching Windows. I'll just mention here the `C-x 4` family of commands that switch to the Other Window and then do something in it; these commands are great when you can think just one step ahead, knowing not only that you want to switch Windows

but what you intend to do when you get there; see Table 8. (See *KIlling Buffers* for `C-x 4 0`, which I think is more of a buffer-killing command.)

Table 8: The `C-x 4` Family of Other-Window Commands

Key	Action in Other Window
`C-x 4 C-f`	Find a file
`C-x 4 f`	... the same
`C-x 4 r`	... the same, but read-only
`C-x 4 b`	switch to a different Buffer (with completion)
`C-x 4 C-o`	... the same
`C-x 4 d`	open Dired on some directory
`C-x 4 C-j`	Jump to this buffer's directory in dired
`C-x 4 m`	compose an email
`C-x 4 .`	find the definition of the identifier at Point
`C-x 4 a`	find `ChangeLog` file and Add an entry

Window Configurations

Often, working in Emacs consists of a fugue-like state of rapidly and almost automatically switching from Buffer to Buffer, with Windows coming and going, as you multitask between, say, authoring, coding, doing email, managing files, and browsing the web. But sometimes you need an exact configuration of Windows and Buffers to stick around (for example, see Figure 50). In this case, a popped-up Window showing `*Help*` or an email can be an irritant if it means you have to manually restore your *Window Configuration*.

There are several facilities to cope with this. The oldest is to use a Register: set up your Windows and Buffers exactly as you want them and then store that configuration in a register with `C-x r w` (`window-configuration-to-register`). It will prompt you for a single-character Register name; pick a (preferably) mnemonic letter. Now, after the usual vicissitudes of the day—popped-up Calendars, Shells, and Web Browsers—have messed-up your beautiful layout, just restore it with `C-x r j` (`jump-to-register`), which will prompt for the Register name you've used.

To be precise, a Window Configuration records the exact sizes and relative positions of all the Windows in the current Frame, and exactly which Buffer was displayed in each Window, and what portion of the Buffer was visible. (You can also save and restore all the Window Configurations in all your Frames in one go; see *Frames*.)

Using Registers requires a little forethought, but it does guarantee perfect restoration of your layout. A more on-the-fly if less precise method is to use *Winner Mode*. This is a global Minor Mode that essentially allows you to Undo Window configuration changes. So

when your carefully-arranged layout is messed up because you had to send that email, and needed to get help while doing it, just use `C-c <C-left>` (`winner-undo`) (perhaps repeated a few times) until you get your configuration back. If you overshoot, you can undo the undo with `C-c <C-right>` (`winner-redo`).

I use Winner Mode all day long and consider it essential. I recommend this Init File snippet (the bindings I describe are my own more felicitous versions of the defaults):

Init File

```
(winner-mode +1) ; undo window config changes
;; add more felicitous bindings
(define-key winner-mode-map [(control c) (control left)] 'winner-undo)
(define-key winner-mode-map [(control c) (control right)] 'winner-redo)
```

There are of course other third-party Packages that deal with Window configurations; I might mention the Hyperbole package that does that (and also many other things).

The Tab Bar

Another way to manage Window Configurations is via the very new *Tab Bar*. Not to be confused with the Tab Line, the Tab Bar is a Frame-specific set of different transient Window Configurations.

Really, I think the Tab Bar is best thought of as a task-based desktop organizational framework. Many people use distinct window manager "desktops" or "tabs" to separate their applications this way: you've got your email application and its many windows in one desktop, your game's windows in another, your word processor in a third, and maybe your web browser in a fourth.

The Emacs way is to do all (or most) of these activities in Emacs, and the Tab Bar gives you that same kind of organization. A given "task" is not so much a precise, unchanging Window configuration, but rather the set of Windows and buffers as you were last using them when you were working on that task. The Tab Bar lets you switch between tasks rather than preserving precise Window configurations.

Before the introduction of the Tab Bar, people would often use a dedicated Frame for each "task" or "desktop". The Tab Bar lets you do it in one Frame.

Note the differences between a Tab and a Window config in a Register:

- Tabs have long names, while Register names are restricted to single characters.
- The set of available configurations is (by default) visible in a Tab

Bar at the top of the Frame, while the Register config is hidden away.

- The configuration of Windows and Buffers in a Tab can be changed as you work, whereas a Register config can only be created from whole cloth once and then restored, precisely, many times.

Turn on the Tab Bar with `M-x tab-bar-mode`; this is a global Minor Mode and so the Tab Bar will be active in all current and future Frames. When you enable the Mode, a single configuration will be created, named for the current buffer. You can change the configuration at will: split Windows and change buffers all you like. So far it doesn't seem any different from *not* using `tab-bar-mode`.

Suppose you've laid out a nice configuration for editing your book, but now you want to read your email for a while. Since this is a distinct task that will implicitly use a different set of Windows and buffers, you should create a new config with `C-x t 2` (`tab-new`) (or use your mouse to click the right-hand + sign in the Tab Bar). Now, in this new, second, config (which you'll notice has popped up in the Frame's Tab Bar), you can open your mailer and read and compose emails. To get back to your book, just click on the book-tab, or switch configs with one of the tab-switching commands in Table 9: your Windows and buffers are restored to the way they were right before you started reading mail. You can now switch back and forth between tasks, or add a new task when needed.

Table 9: The `C-x t` Family of Tab Bar Commands

Key	Action
`C-x t 2`	create a 2nd (really, a new) tab
`C-x t C-f`	... by Finding a File
`C-x t f`	... (the same)
`C-x t b`	... by switching to a Buffer
`C-x t d`	... by Dired
`C-x t o`	switch to the Other (next) tab
`C-x t RET`	... by name (with completion)
`C-x t 0`	zero (delete) this tab
`C-x t 1`	make this tab the only 1 (delete all others)
`C-x t r`	Rename this tab
`C-x t m`	Move this tab to the right
`C-x w ^ t`	move this window to its own new Tab in the Tab Bar

A Register configuration has one advantage that a Tab Bar config doesn't have: a Register config is *immutable*. You'll note that while you're in a given Tab, you can change the Windows, buffers and their visual relationship at will, so once you've laid out a precise configuration in your Tab, you may still want to store it in a Register so you can get it back, or use Winner Mode to undo config changes.

If you use `desktop-save-mode` to save and restore the state of your Emacs between sessions, using `tab-bar-mode` will result in all your Tabs being restored as well.

I must admit that before writing this section, I was completely confused about the Tab Bar and the Tab Line. So what *is* the difference between them?

- There's one Tab Bar per Frame, but there's one Tab Line per Window
- Each tab in the Tab Bar is a (fluid) named Window configuration, whereas each tab in the Tab Line is a Buffer that you've displayed in the current Window.

  You can of course use both of them at once.

Tweaking Window Sizes

Speaking of Window configurations with precise layouts, well, how exactly do you arrive at those precise Window sizes?

Mouse users can just click and drag with mouse button 1 on a Mode Line to resize a Window in the vertical axis (that is, make a Window taller or shorter), or on the Window divider line between two side-by-side Windows to make a Window narrower or wider. Of course, to make one Window taller or wider, Emacs will have to steal space from a neighboring Window (because tiling). And note that when clicking in a Mode Line, you need to avoid clicking on any of the Mode Line components that have their own response to mouse clicks—most printed text or graphics in the Mode Line reacts to mouse clicks. Find a spot (typically blanks) where the mouse cursor changes to a double-headed arrow before clicking.

For us mouse avoiders, there are key bindings that achieve the same effects; see Table 10.

Table 10: Window Resizing Commands

Key	Action
`C-x ^`	make selected window one line taller
`C-x }`	make selected window one character wider
`C-x {`	make selected window one character narrower
`C-x -`	shrink this window if its buffer doesn't need so many lines
`C-x w -`	similar, see below
`C-x +`	make all windows the same height (balance windows)

The first three commands in Table 10 can take a positive numeric argument *N* to operate *N* lines (or characters) at a time, and can take a negative arg to operate in the opposite direction. But fiddling with Window sizes is tricky and when you want to, say, make a Window

wider, usually a precise number of characters doesn't immediately jump to mind such that you efficiently utter something like `C-u 17 C-x }`. You really want to repeatedly invoke `C-x }`, perhaps with your keyboard's auto-repeat, until it looks exactly right. But these two-stroke bindings are infelicitous and can't be autorepeated, so I recommend the following felicitous bindings (unassigned in a stock Emacs) for your Init File:

Init File

```
(keymap-global-set "C-{" 'shrink-window-horizontally)
(keymap-global-set "C-}" 'enlarge-window-horizontally)
(keymap-global-set "C-^" 'enlarge-window)
```

The `windsize` package defines four mnemonic key bindings on the control-shifted arrow keys which by default resize by 8 columns or 4 rows per keystroke; I include these in the Init File:

Init File

```
(require 'windsize)
(windsize-default-keybindings)  # resize windows on C-S-<left> etc
```

Finally, `C-x -` (`shrink-window-if-larger-than-buffer`) is very handy when you're working in a buffer that only has a few lines in it, but whose Window eats up 50% of your screen real estate. `C-x w -` (`fit-window-to-buffer`) does the same thing, but is also able to shrink windows horizontally, for users who use a lot of side-by-side windows.[124]

`C-x +` (`balance-windows`) divides all the Frame-space evenly between all the Windows.

[124] This feature is off by default; Customize `fit-window-to-buffer-horizontally` to turn it on.

Vertical Scrolling

Even though there are often better ways to move, if you just need to move one character forward, nothing beats `C-f` (`forward-char`) or `<right>` (`right-char`). On the other hand, if you know you need to move *somewhere*, but don't really know exactly where, nothing beats scrolling for an overview of your text.

We've already met `C-v`, `M-v`, and `C-M-v` in an earlier chapter, and you can of course also use the scroll bars and the mouse wheel.

Remember that *moving* means "moving Point", i.e. changing your position in the buffer. Strictly speaking, *scrolling* isn't a way of moving Point: it's a way of adjusting the portion of the buffer's text that's visible in a Window; but this often has the *side-effect* of moving Point.

Here we have a 10-line Window. Imagine that the buffer is hundreds of lines larger than the Window. The Window line numbers are at the left, and the buffer line numbers are to the right of them.

The word "FOO" is in the middle of buffer line 655, which happens to be shown in Window line 5 at the moment, and Point, in-

dicated by |, is at the beginning of "FOO". (Lines 650 and 661, and many more, are outside the Window.)

```
       650   Lorem ipsum dolor sit amet, consectetuer adipiscing elit
+--------------------------------------------------------------------+
|  1 | 651 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  2 | 652 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  3 | 653 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  4 | 654 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  5 | 655 | Lorem ipsum dolor sit |FOO, consectetuer adipiscing elit |
|  6 | 656 | Lorem ipsum dolor sit  BAR, consectetuer adipiscing elit |
|  7 | 657 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  8 | 658 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  9 | 659 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
| 10 | 660 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
+--------------------------------------------------------------------+
       661   Lorem ipsum dolor sit amet, consectetuer adipiscing elit
```

If we *scroll up* by 4 lines, say with `C-u 4 C-v`, the line with FOO will now be displayed in Window line 1; Point remains at the beginning of "FOO".

```
       654   Lorem ipsum dolor sit amet, consectetuer adipiscing elit
+--------------------------------------------------------------------+
|  1 | 655 | Lorem ipsum dolor sit |FOO, consectetuer adipiscing elit |
|  2 | 656 | Lorem ipsum dolor sit  BAR, consectetuer adipiscing elit |
|  3 | 657 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  4 | 658 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  5 | 659 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  6 | 660 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  7 | 661 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  8 | 662 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
|  9 | 663 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
| 10 | 664 | Lorem ipsum dolor sit amet, consectetuer adipiscing elit |
+--------------------------------------------------------------------+
       665   Lorem ipsum dolor sit amet, consectetuer adipiscing elit
```

This is why Emacs calls `C-v` "`scroll-up-command`", rather than "scroll-down": the buffer lines have moved *up* in the Window. It's also true that more buffer lines are suddenly visible at the bottom of the Window (lines 661-664).

So scrolling isn't really moving: the position of Point has not changed! However, it is a rule that Point is *always* visible in the Window, so if we were to scroll up one more line, Point would *have* to move to remain in the Window.

If we scroll by large amounts — bigger than the size of the Window, say by a screen-full at a time — then Point will be moving every time. But the motion of Point is really just a side-effect.

Conversely, if you move Point off the top or bottom of the Window with a true Point-moving command like `C-p` (`previous-line`) or `C-n` (`next-line`), because Point must remain visible, Emacs will scroll the Window to achieve this! By how much will it scroll? The default is to scroll Point to the center of the Window, which I hate – I think it makes scrolling jumpy and my eyes lose track of Point.

Different people simply don't agree about these things, but Emacs being Emacs, all aspects of scrolling can be fine-tuned with a variety of variables. I use:

```
(setq scroll-conservatively 100000)
```

The result of this (just trust me...) is that the Window only scrolls by one line if I move one line off the top or bottom. (If you read the documentation for that variable, the number will make sense.)

Where in the Window is Point?

Sometimes you want Point to stay where it is in the buffer (in front of some given word, perhaps), but you want it to be on some other Window-line. If Point is on the bottom line of the Window, you might want to center it so that you can see as many lines before and after it as possible.

You can do that by fiddling with numeric arguments for `C-v` and `M-v`, but as usual there are commands to make that easier. `C-l` (`recenter-top-bottom`) will scroll the Window so that Point is in the center line; immediately repeating `C-l` will scroll Point's line to be at the top of the Window; one more `C-l` scrolls it to the bottom; yet one more starts the cycle over[125]. I use this command constantly; so much nicer than vaguely yanking the scroll bar.

Conversely[126], you might want to really move Point to a particular, different, Window line, without scrolling the lines at all. `M-r` (`move-to-window-line-top-bottom`) does that, and it cycles through the same positions that `C-l` does when you repeat it; first Point jumps to the line at the center, then the top and finally the bottom: the visible lines remain the same, in the same positions.

These are easy to understand if you just try them out: pull up some text that's significantly bigger than your Window (`C-h C-c` (`describe-copying`) will probably do), scroll a few screenfulls in with two or three `C-v`'s, and then type several `C-l`'s in a row until you get the idea. Now do the same with a sequence of `M-r`'s.

Finally, new to me as I write this paragraph in 2021[127] is `C-M-l` (`reposition-window`), which recenters the Window heuristically, trying to bring useful information into the Window, like a complete paragraph or a complete function definition.

[125] You can fine-tune these positions by tweaking the variable `recenter-positions`.

[126] With Emacs, there's always a "conversely"...

[127] Even though it's been around since 1993...

The Display of Lines

While the size of a Buffer is effectively unlimited (2.3 exabytes), the size of a Window definitely is *not*. It depends on the resolution of your display, your chosen font size, the current size of your Frame,

and the sizes of any other Windows in that Frame. Scrolling copes well for buffers with many more lines than the Window has room for, but (in my opinion) is basically awful for lines longer than the Window is wide.

Continuation Lines

By default, horizontal scrolling is completely avoided by virtue of *continuation lines*. When the actual length of a line in a buffer—i.e., the number of characters between the beginning of the line and a newline character—is longer than the Window width, Emacs displays it *wrapped* on as many Window lines as it requires. So there are two kinds of lines: actual lines (determined by the content of the buffer), which Emacs calls *logical lines*, and the *screen lines* needed to display the logical line in full. Any extra screen lines needed for this are called *continuation lines*.

Continuation lines imply some ambiguity: the additional screen line-breaks would masquerade as actual newlines in the buffer text. To solve this problem, the continuation line-breaks are indicated by bent arrows in the right and left Fringes of the Window[128]; if you have `display-line-numbers-mode` turned on, you'll note that the continuation lines don't get line numbers (`display-line-numbers-mode` numbers logical lines); see Figure 18.

[128] In a non-graphical terminal, which can't display fringes, a backslash character (\) is used.

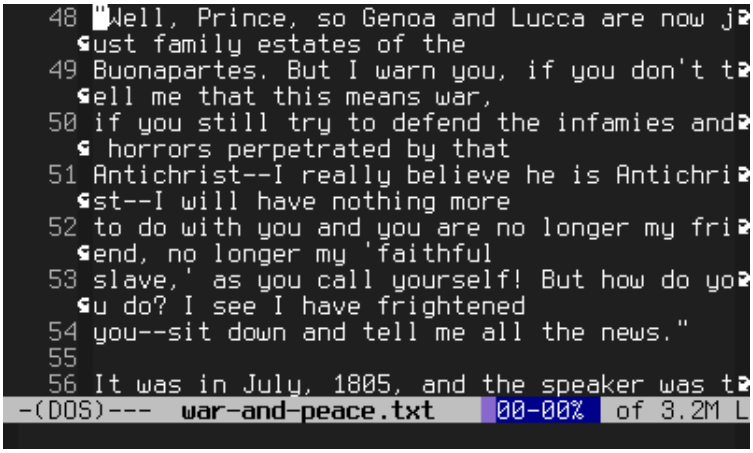


Figure 18: Continuation Lines

All the line-motion commands work in terms of logical lines, so getting to the last word in a logical line continued into many screen lines (say from the cursor in Figure 18 to the word "estates") requires using *horizontal* motion commands (or, of course, Incremental Search).

Line Truncation

The occasional continuation line is no hardship, and if you have many, it may be because your Window is only temporarily too skinny and will soon be wider. But when *every* line in the buffer is too long to fit (as in Figure 18), it can really be annoying. I use a tiling window manager and as result, my Emacs frame can often be somewhat narrow, and Emacs itself tiles its Windows, so every `C-x 3` (`split-window-right`) can mean more continuation lines. What to do?

My solution is to use *line truncation* instead of continuation lines, via this Init File snippet:

```
(setq-default truncate-lines t)                ; good for tiling window managers
```

With this setting, there are no continuation lines: the line is (visually) truncated at the right-hand Window boundary and the right fringe shows a right-pointing arrow to indicate that there's more of the logical line off to the right. This avoids the disconcerting continuation lines, but at the cost of horizontal scrolling.

Since I hinted that I hate horizontal scrolling (especially yanking back and forth on a horizontal scroll bar), this may sound like a counterintuitive choice, but of course, if you simply move Point into the off-screen part of a truncated line, Emacs scrolls automatically; remember, Point is *always* visible in the Window, so this means anything that moves Point, like searching, causes automatic horizontal scrolling as needed.

Still, even automatic horizontal scrolling can be annoying, but thanks to Winner Mode, which lets me use `C-x 1` (`delete-other-windows`) to get a wide Window and with one keystroke restore my previous Window configuration, `truncated-lines` work for me.[129] See Figure 19 (and notice how many more (partial) lines are visible).

[129] I'm also an old Unix programmer-type, and most of the files I work with have short lines.

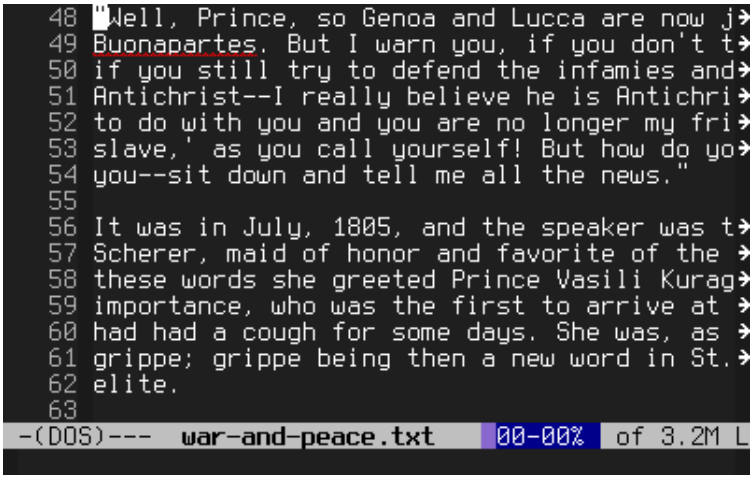


Figure 19: Truncated Lines

You probably don't want truncated lines as a global default the way I have it, but you can switch any Window back and forth between continuation and truncated with `M-x toggle-truncate-lines`.

Visual Line Mode

Neither truncated lines nor continuation lines are suitable for actually working with (i.e., editing or reading) the modern style of single-line paragraphs, or any other bunch of really long lines. For this purpose, you want *Visual Line Mode*.

Visual Line Mode wraps your lines into continuation lines *at word boundaries*, exactly the way your phone does it; Emacs inserts no indication of wrapped lines at the fringes (though `display-line-numbers-mode` still gives it away).

Let's pretend my copy of *War and Peace* is formatted with single-line paragraphs. In Visual Line Mode it would look like Figure I.

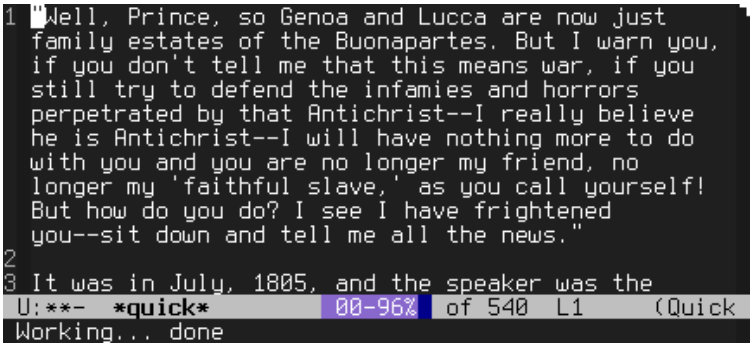


Figure 20: Visual Line Mode

The biggest difference is that in Visual Line Mode, the vertical line motion commands (like `C-n` (`next-line`) and `C-p` (`previous-line`)) move by screen lines, rather than logical lines. So this is definitely the natural way to work with single-line paragraphs.

You can use `M-x visual-line-mode` to switch in and out of this mode in any Window, and if, unlike me, most of your files are structured as single-line paragraphs, you can make it your default everywhere with this Init File snippet:

```
(global-visual-line-mode +1)            ; single-line paragraphs rule
```

The Horizontal Scroll Bar: the Last Resort?

With truncated lines, sometimes you actually *do* need to scroll horizontally. In a graphical-mode Emacs, you may have a horizontal scroll bar, which is certainly one way to do it. If you don't have a horizontal scroll bar and you *want* one, you can turn it on and off in the

current Window with `M-x toggle-horizontal-scroll-bar`, or make it a global default with this Init File snippet:

```
(horizontal-scroll-bar-mode +1)
```

You can also scroll horizontally with `C-x >` (`scroll-right`) and `C-x <` (`scroll-left`), which are the keyboard equivalents of yanking on the horizontal scroll bar. By default each invocation scrolls by the Window's width (with a slight overlap), but of course they take a numeric argument; multiple `C-u`'s are useful here. Naturally you can also change the default scroll units.

The defaults are very infelicitous bindings so I recommend adding this to your Init File and using these instead.

Init File

```
(keymap-global-set "C-<" 'scroll-left)
(keymap-global-set "C->" 'scroll-right)
```

The Header Line

A Window can optionally display a *Header Line* at the top which is rather like an additional Mode Line. Header lines are generally created by certain Major Modes and the most common use is to display headers for column-oriented data. Try `M-x list-buffers` to see one in action; like most columnized Header Lines, you can usually sort the columns by mouse-clicking in the Header. The Header is really a display of the contents of the Buffer-Local Variable `header-line-format`; it's in no way part of the Window's Buffer's text.

The Fringes

The left and right *Fringes* are very narrow areas of the Window mainly used to display graphical indicators that are matched to Window lines, most commonly continuation lines and truncated lines (see *The Display of Lines*), but also *buffer boundaries* that eliminate the ambiguity of the presence of blank lines at the end of a buffer (see *Displaying Boundaries* and "Useless Whitespace" in the *Emacs* manual); to indicate added and deleted lines in `diff-mode`; and in the special modes for running debuggers for various programming languages (including, of course, Elisp).

If you'd like a see a Fringe in action, try making a new buffer (`C-x b newbuffer`), make it the only Window in the Frame (`C-x 1`), and type in one line of text. Note all the blank screen lines after your single logical line. How do you know those screen lines aren't actual empty lines in the Buffer (consisting of many blanks and/or newlines)? Now say `M-x toggle-indicate-empty-lines`; you should

see a change in the left Fringe. Now actually add a few empty lines at the end of the Buffer by hitting `RET` a few times: note how the Fringe makes clear which lines are really in the Buffer and which are just an artifact of the display.

Follow Mode

If you have a very wide, high-resolution display, it may seem like you're wasting screen real estate when you're editing a buffer whose lines are significantly shorter than its Window's width: much of the right-hand side of the Window will just be blank space. The Unix system dictionary file—`/usr/share/dict/words` on my machine—is a particularly skinny example, since each of its 123,985 lines is a single word; see Figure 21.

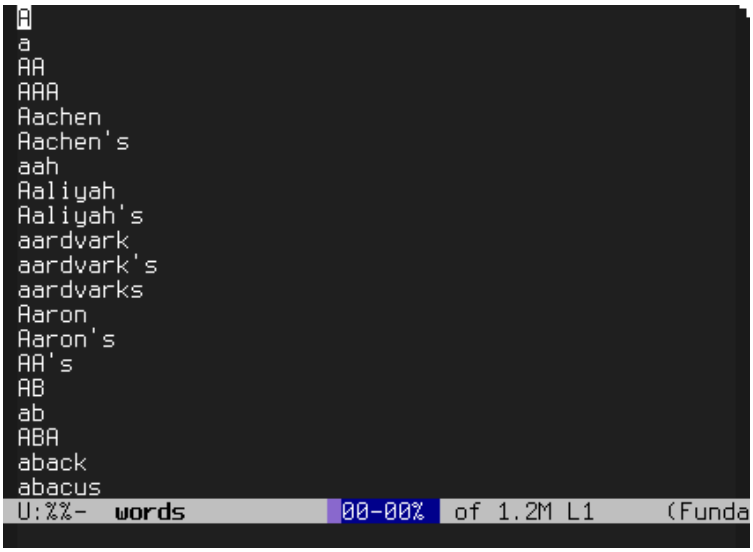


Figure 21: The Tragedy of Wasted Screen Real Estate

Follow Mode lets you exploit this empty space to show more lines of your Buffer. Just say `M-x follow-mode` and now split your Window with `C-x 3` (`split-window-right`). Normally, after `C-x 3`, the new Window initially shows exactly the same text as the old Window: the top screen line of the old Window is the top screen line of the new Window. But when Follow Mode is active, the top line of the new Window is the *line after the bottom line of the old Window*: it's as if the two Windows comprise a single virtual Window that's twice as tall as the original. Another `C-x 3` gives you a virtual Window that's *three* times as tall. You can have as many splits as make sense, given the lengths of your logical lines. Figure 22 shows the same file after six `C-x 3`'s; I've turned on `display-line-numbers-mode` to show how the screen lines are related to the Buffer's logical lines.

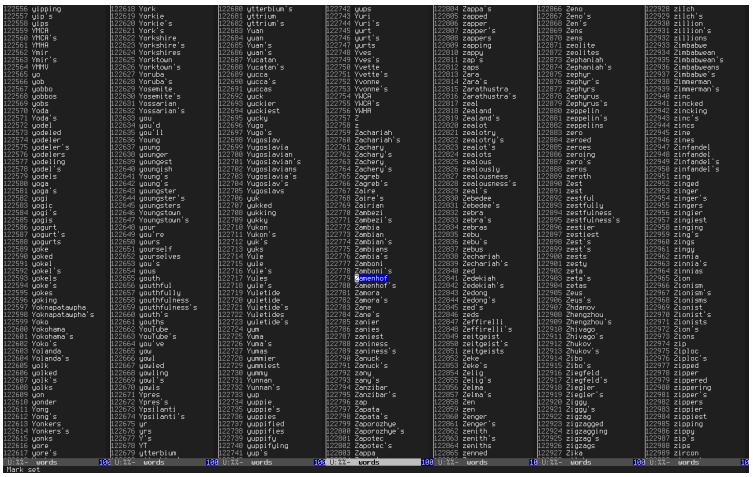


Figure 22: Follow Mode

Follow Mode isn't just a trick to initialize the positions of the lines in the Windows! If you move Point off the bottom of one Window with some invocations of `C-n` (`next-line`), the cursor will appear at the *top* of the next Window. If you search for a word that's visible in one of the other Windows, Point (and the cursor) will just jump there without scrolling any of the Windows. And if you *do* scroll, all the other Windows scroll in lock-step to maintain the tall virtual Window effect. You can delete Windows and re-split them at will, and you can have `C-x 2` (`split-window-below`) splits with different Buffers in the same Frame; Follow Mode will keep all the Windows that are displaying the same buffer in sync.

There's a related Minor Mode, `next-error-follow-minor-mode`, which is typically bound to a keystroke in modes like `grep-mode`, `occur-mode`, `compilation-mode`, and the like, which makes motion in the hits Buffer cause automatic scrolling in the associated target Buffer.

Scrolling Many Different Buffers at Once

This style of lock-step scrolling can be useful with *different* Buffers displayed in separate Windows, too. Suppose you have two Buffers with related data: the information on line *N* of the first Buffer is related to that on line *N* of the second Buffer, and so on. You can display these two Buffers side by side, with their lines lined-up, but if you scroll one of them, now you're out of sync. `M-x scroll-all-mode` will synchronize all the Windows in the Frame as you scroll one of them.

The (New) Windows Keymap

As of Emacs v29.1, there's a new Prefix key `C-x w` that holds a small number of new or previously unbound Window commands. We've already discussed some of these. Side windows are a fairly obscure feature that I've never used (you can't set them up without using Elisp), though they might be a prominent part of libraries or package that I don't use. The `C-x w ^` commands *tear* a window out of its current Frame or Tab.

Table 11: The `C-x w` Windows Keymap

Key	Action
`C-x w -`	fit window to buffer
`C-x w 0`	delete *all* windows displaying this buffer
`C-x w 2`	open a 2nd window below all your current windows
`C-x w 3`	open a 2nd window to the right of all your current windows
`C-x w s`	toggle Side-windows
`C-x w ^ f`	move this window to its own new Frame
`C-x w ^ t`	move this window to its own new Tab in the Tab Bar

The Mode Line in Detail

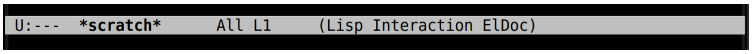


Figure 23: The Mode Line

Every Window has a Mode Line at its lower edge[130]. If your Frame only has one Window, its Mode Line is above the Frame's Echo Area. The Mode Line displays dynamic information about the Window's Buffer—the Buffer name, its Major Mode, and more: some of this info is shown in a terse and even cryptic form.

The Mode Line is completely customizable, but out of the box it has the following main components:[131]

```
U:@**-  *scratch*    All L1   Hg:94daf  (ELisp ElDoc)
CEFBB-     BUF       POS LINE    VC     (MAJOR MINOR ...)
```

C a terse indication of the Buffer's *Coding System* or character set

E the Buffer's end-of-line convention

F an `@` if this is a client frame

B the Buffer's state relative to the file on disk (if it's visiting a file)

BUF the Buffer's name (which is typically also the name of the file it's visiting, if any)

POS the position of the visible Window text vis à vis the Buffer text

LINE the number of the line Point is in

VC the Version Control state (if the Buffer is visiting a file under Version Control)

MAJOR the Buffer's Major Mode

MINOR (some of) the Buffer's Minor Modes

[130] The Mode Line is actually optional (EIPNIF) —you can turn it off by setting `mode-line-format` to `nil`: but it's so useful and has so little cost in screen real estate that I don't see why you would.

[131] The first line here is an example of a Mode Line; in the second I'm labeling the various components for the sake of discussion.

C — *Coding Systems*

There are about 50 single-character values indicating the most common Coding Systems that can appear in the *C* column. Here are a few of them; how likely you are to see any of these depends on where you live, what language you speak, and the kind of files you edit. The real way to learn a Buffer's encoding is to execute `M-x describe-current-coding-system` in the Buffer.

`U`	various Unicode UTF encodings
`1`	ISO Latin-1
`-`	US ASCII
`=`	raw, unencoded (binary) data
`*`	Windows 1250
`D`	various DOS code pages
`c`	Chinese GB2312
`B`	Chinese BIG5
`J`	Japanese
`K`	Korean

E — *End-of-Line Encodings*

This can be a single character if the Buffer's end-of-line encoding is the normal one for your operating system, or else a word in parentheses.

`:`	`(Unix)`	Unix newlines (line-feeds)
`\`	`(DOS)`	MS-DOS (Windows) CRLFs
`/`	`(Mac)`	Old Macintosh carriage returns

F — *Client Frame Indicator*

If there is an `@` in this position it indicates that this Frame was created by the Emacsclient (and so this Emacs is necessarily an Emacs Server); see *Client / Server*.

B — *Buffer State*

This indicates the Window's Buffer's state versus the file it's visiting, if any.

`--`	Buffer unmodified
`**`	Buffer modified
`%%`	Buffer read-only and unmodified
`%*`	Buffer read-only and modified

BUF — *Buffer Name*

This is simply the Buffer name, which for file-visiting Buffers is usually the basename of the file, possibly modified for disambiguation.

POS — *Visible Text Position*

This is a hint of how much of the Buffer is visible in the Window.

`Top`	Beginning of Buffer is visible
`Bot`	End of Buffer is visible
`All`	All of Buffer is visible
`NN%`	*NN* percent of Buffer precedes visible portion

LINE — *Point's Line Number*

Self-explanatory.

VC — *Version Control State*

If the Buffer's file is under Version Control (*VC*), the Mode Line will indicate the file's VC state in the form: *BE-ID* (for example, `Hg:94daf`):

BE the (abbreviated) name of the VC back-end

\- the status of the file, indicated by a single character

ID the version number (or version identifier) of the file

For the possible values of *BE*, see the list of version control systems (*VCS*'s) in *Version Control*. *ID* is whatever your system uses to identify a version number; for RCS it might look like `1.22` whereas for a distributed VCS like Mercurial or Git it will probably be a hexadecimal number like `94daf`.

The *:* can actually be any of the following status indicators:

`-`	file is unmodified (or unlocked)
`:`	file is modified (or locked)
`!`	file contains merge conflicts or was removed from VC
`?`	file is in VC but missing from the working directory
`@`	file was added locally but is not committed

Note that in an old-fashioned lock-based VCS (like RCS), a username may also be present—*e.g.*, `RCS:jim:1.3`—indicating that user `jim` has the file locked.

MAJOR — *Major Mode Name*

The name of the Buffer's Major Mode, with the `-mode` elided, so e.g. `Fundamental` for `fundamental-mode`, `Org` for `org-mode`.

MINOR — *Minor Modes*

This is a space-separated list of strings, called "indicators" or "lighters", identifying enabled Minor Modes. Unlike the Major Mode indicator, these are optional: a given Minor Mode may choose to use a very abbreviated indicator, or none at all. So many Minor Modes are typically in use that many of the ones that are enabled by default—e.g. `auto-encryption-mode`, `auto-compression-mode`—use no indicator just to save space in the Mode Line.

The Mode Line and the Mouse

The Mode Line, being one of the few things in Emacs that's inaccessible to the keyboard, has a small number of mouse bindings. They come in two flavors:

1. mouse clicks on Mode Line text (or images) (e.g. the Buffer name, a Mode indicator, the Coding System character (class *C* above)), and
2. mouse clicks in any of the blank space between the textual elements; these clicks allow you to select, resize, or delete windows.

   Taking the latter category first, we have the following:

Mouse Button	Mouse Action	Effect
`mouse-1`	click	select the Mode Line's Window
	drag	resize Windows vertically
`mouse-2`	click	like `C-x 1` in the Mode Line's Window
`C-mouse-2`	click	like `C-x 3` in the Mode Line's Window
`mouse-3`	click	like `C-x 0` in the Mode Line's Window

As for mouse clicks in the textual or graphical elements, they vary to suit: just hover the mouse over the element and, in the Echo Area, you'll see a brief description of the element and what various clicks will do.

Optional Mode Line Features

There are several optional Mode Line features that you can turn on, and you can customize the appearance with a variety of formats

and Faces. The best way to do this is via `M-x customize-group RET mode-line`.

`size-indication-mode` displays the total size of the Buffer after *POS*, in a form like `74% of 712k`.

`column-number-mode` displays Point's column number next to the line number

`display-time-mode` displays the current time, load average, and an indicator when you have new mail.[132]

`display-battery-mode` displays the percentage remaining of your laptop's battery charge.

There are also at least 58 third-party packages to enhance your Mode Line, including popular theming to make your Emacs look a little less Emacs-like.

[132] Only if you receive your mail locally; see *Mail, News, and Feeds*.

Frames

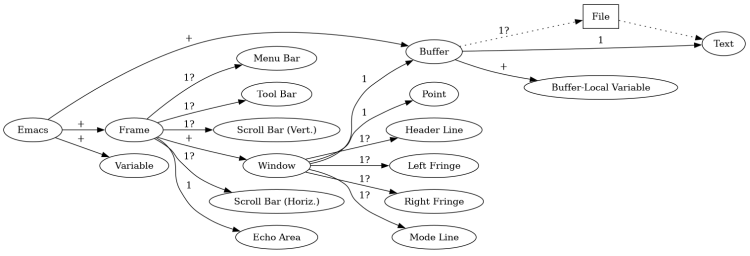


Figure 24: Emacs Data Structures

Legend:

+	One or more
1	Exactly one
1?	One or none

When you fire up Emacs, a new "window" pops up: not an Emacs Window, but an operating system or desktop window. Earlier I mentioned that, since Emacs had multiple Windows two years before Graphical User Interfaces were commercially available, it needed a new term for this object: a *Frame*.

A Frame consists of at least one Window, and has a Menu Bar, Tool Bar, Scroll Bars (vertical and horizontal)[133], and an Echo Area, as in Figure 25.

[133] The Menu Bar, Tool Bar, and Vertical Scroll Bar are turned on by default, but you can turn them off.

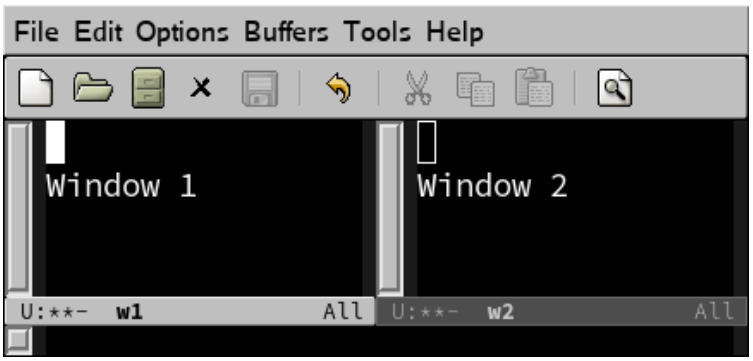


Figure 25: A Frame with Two Windows

You can create as many additional Frames as you like, and use them as another way to organize your work, as you can with the Tab Bar for example.

You can of course delete any Frames you create; deleting a Frame *does* necessarily delete all the Windows in it, but as usual in no way kills the Buffers in those Windows. Deleting the last and only Frame

is the same thing as exiting Emacs with `C-x C-c` (`save-buffers-kill-terminal`);[134] as always, Emacs will ask for confirmation if you have any unsaved Files.

[134] Unless you're running the Server.

Frame Commands

The main commands for working with Frames are all on the `C-x 5` prefix (see Table 12); they're completely analogous to the `C-x 4` family of Other Window commands: where a `C-x 4` command is a shortcut to something in another Window, the corresponding `C-x 5` command does the same thing in a new Frame. The fundamental Frame-creation command is `C-x 5 2` (`make-frame-command`) (mnemonic: makes a 2nd Frame); you can also make a new Frame initialized with some file, Buffer, or the like.

Table 12: Frame Manipulation Commands

Key	Type	Action
`C-x 5 2`	Create	create a 2nd frame
`C-x 5 C-f`		Find a file in a new frame
`C-x 5 f`		... the same
`C-x 5 r`		... the same, but Read-only
`C-x 5 b`		switch to a Buffer in a new frame
`C-x 5 C-o`		Open a buffer in another frame
`C-x 5 m`		compose an eMail in another frame
`C-x 5 d`		open a Dired in another frame
`C-x 5 .`		find the definition of the identifier at Point
`C-x 5 5`		run the next command in a new frame
`C-x 5 0`	Delete	zero-out (delete) the current frame
`C-x 5 1`		make the current frame the 1 and only frame
`C-x 5 u`		Undelete the most recently deleted frame
`C-x 5 o`	Switch	switch to the Other frame
`C-x w ^ f`	Move	move the selected Window to its own new Frame

The most general-purpose of these commands is `C-x 5 5` (`other-frame-prefix`), which waits for your next command (any key binding, including `M-x` (`execute-extended-command`)) and then displays that next command's Buffer in a new frame. (It's the Frames version of `C-x 4 4` (`other-window-prefix`).) So while a command like `M-x apropos` normally pops up its list of commands in a new Window in the current Frame, `C-x 5 5 M-x apropos` will pop up that Buffer in a brand new Frame. It's a shorthand for some more complex sequence of commands like:

```
C-x 5 2 M-x apropos C-x 4 b *Apropos* RET C-x 1
```

`C-x 5 0` (`delete-frame`) deletes the current Frame; as mentioned above, if the current Frame is the *only* Frame, this is equivalent to

exiting Emacs[135]. `C-x 5 1` (`delete-other-frames`) deletes all your Frames *except* for the current one. These two commands are analogous to `C-x 0` (`delete-window`) and `C-x 1` (`delete-other-windows`). You can undelete the most recently deleted Frame with `C-x 5 u` (`undelete-frame`); with a Prefix argument of *N* you can undelete the *N*-th most recently deleted Frame.

N.B. The ability to undelete Frames (a relatively new feature) is off by default; you need to enable it in your Init File with:

Init File

```
(undelete-frame-mode +1)                ; bring back deleted frames
```

Finally, `C-x 5 o` (`other-frame`) is like `C-x o` (`other-window`), but it always switches to another Window in a Frame other than the current one (so it has no effect if you only have one Frame). If you repeat this command, it cycles through all the Frames you have open. Note that Emacs has to delegate this action to your window manager (WM) or operating system (the WM is in charge!), so you may have to tweak your WM or Emacs itself to make this work the way you want; see "Frame Commands" in the *Emacs* manual for details.

[135] The rules are slightly different if you're running the Emacs Server.

Frames and Monitors

Some lucky people have more than one monitor connected to their desktop computer (especially in an office situation). You can pop up a Frame on a particular monitor with `M-x make-frame-on-monitor`; you'll be able to use Completion on whatever monitor names your operating system has assigned.[136]

[136] For Unix users running X Windows, you can also open new Frames on other X displays or servers; see "Multiple Displays" in the *Emacs* manual.

Controlling Graphical Window Elements

Some people find the various GUI elements of Frames to be an annoyance. While I recommend that you exploit the Menu Bar and Tool Bar while you're getting comfortable with Emacs, here's how to disable any of these elements if and when you want to (I disable all of these).

Best is to use Customize via `M-x customize-group RET frames`. If you're inclined to disable any of these elements, you may also want to disable GUI dialog boxes and tool tips (and use Emacs Completion instead)[137]; use `M-x customize-group RET menu`. You can also just add one or more of these snippets to your Init File:

[137] I find these to be excruciatingly slow if you run the Emacs Client over a network connection to a remote machine (and anyway, Emacs Completion is far superior to any GUI dialog box).

```
(menu-bar-mode -1) ;turn off menu bar
(tool-bar-mode -1) ;turn off tool bar
(scroll-bar-mode -1) ;turn off vertical scroll bar
(horizontal-scroll-bar-mode -1) ;turn off horizontal scroll bar
```

```
(tooltip-mode -1) ; turn off GUI tooltips
(setq use-file-dialog nil use-dialog-box nil) ; turn off GUI dialogs
```

Customizing Frame Appearance

You can extensively customize the appearance of your Frames: things like size, position on your monitor, fonts, colors, cursors, and much, much more. Many of these can't be done via Customize; see "Frame Parameters" in the *Emacs* manual.

If you use `desktop-save-mode`, it will remember any changes to your Frame parameters, including implicit changes: if you embiggen the font or screen position of a Frame, the next time you start up Emacs, that Frame will be restored at its last screen position and font size (assuming your window manager is okay with this).

Saving Frame Configurations

We discussed how you can save your Window configuration in a Register with `C-x r w` (`window-configuration-to-register`) so that you can restore it with a keystroke. That Window configuration is merely the set of Windows in your current Frame. But you can also save your entire configuration of *all* Frames with all their Windows in one step with `C-x r f` (`frameset-to-register`).

Frames in Non-Graphical Mode

Even a non-graphical Emacs supports multiple Frames, but in a very limited manner: each Frame always uses the full screen of the terminal it's running in, so you can only see one at a time, and elaborate Frame parameters aren't supported (just because terminals can only do so much compared to what Emacs can do in graphical mode).

Files

Most of what we think of as "editing files" really consists of editing *Buffers*, but there are a number of topics that apply specifically to files and how they relate to Buffers. For files as the contents of directories, and performing file maintenance operations like copying, renaming, and the like, see *Directories*.

Visiting Files

As already mentioned, the usual way to *visit* a file (i.e., load it into Emacs for editing) is `C-x C-f` (`find-file`), but there are a few other useful variants. First, we have variants for finding files in specific ways:

`C-x C-r (find-file-read-only)` This is just like `C-x C-f` followed by `C-x C-q` (`read-only-mode`); you can use this when you want to make sure you don't forget and start editing a file you only want to look at.

`M-x find-file-existing` This is just like `C-x C-f` but it won't let you create a new file. I've never used it; it's probably most useful if you're trying to pull up a file whose name contains wild cards (*glob* characters), like `*` or `?`, because it won't expand them. It's a little-known (and by me, little used) feature of `find-file` that if you use wild cards in the file name, it will load all the matching files into multiple Buffers.

Let's talk about neatness. Some people accumulate dozens of file Buffers in their Emacs (even hundreds, for users of `server-mode`), but others like to keep a lean and mean Emacs by killing Buffers ASAP when they're done with them. `C-x C-v` (`find-alternate-file`) is designed for the ASAPers. It replaces the file you're editing with a different file, whereas `C-x C-f` adds an additional file to your Emacs. It's just like doing `C-x k` (`kill-buffer`) immediately followed by `C-x C-f`, except it also reuses the Window of the killed Buffer, so your Window layout doesn't change at all. This is also often used

when you visit a file and immediately realize that it wasn't the file you meant: `C-x C-v` let's you correct the mistake. Note that this is a brand-new Buffer, so if you've made any Buffer-local changes to the previous file's Buffer, like say turning on a Minor Mode, they are lost.

Then we have a family of convenience commands that simply open a file in a different Window. `C-x C-f`, `C-x C-r`, and `find-file-existing` all open the file in the current Window; these commands save you the effort of splitting Windows and rearranging Buffers:[138]

- `C-x 4 f` (`find-file-other-window`)
- `C-x 4 r` (`find-file-read-only-other-window`)
- `C-x 5 f` (`find-file-other-frame`)
- `C-x 5 r` (`find-file-read-only-other-frame`)

[138] You'll recall that `C-x 4` is the keymap for commands that do things in other Windows, and `C-x 5` is for other Frames.

Finally, `M-x find-file-literally` visits a file but shows you the literal contents of the file. This means that the Major Mode will be `fundamental-mode`, regardless of what it would normally be (so no syntax highlighting); line ending- and character set-conversion will not be done, and multi-byte characters (as in Unicode) will be shown as individual bytes. Normally helpful features like automatic handling of compressed, encrypted, and archive files (see below) will not be done.

When visiting a non-existent file (to create it), you might want to specify a path that contains one or more non-existent directories. Suppose the directory `~/txt` exists, but contains only plain files—no subdirectories—and you say `C-x C-f ~/txt/emacs/how-to.org`. Emacs will happily open up a new Buffer for you, but you'll see this message in the Echo Area:

```
Use M-x make-directory RET RET to create the directory and its parents
```

You should take the advice. You don't *have* to do it immediately, but as soon as you start typing in this Buffer, you'll start getting warning messages as Emacs repeatedly tries, but fails, to create the Buffer's checkpoint file in the non-existent directory:[139]

```
Error (auto-save): Auto-saving how-to.org: Opening output file:
  No such file or directory, ~/txt/emacs/#how-to.org#
```

[139] I suppose you could instead disable `auto-save-mode`, but I mean, just make the directory already.

You can also use `M-x make-directory` anytime you need a new directory, just as with `mkdir` in the shell; note that `make-directory` always acts like `mkdir -p` and makes all necessary intermediate directories for you.

Find File at Point

`M-x find-file-at-point` is extremely useful for when you're looking at the name of a file in some Buffer, and want to open that file[140]. Just move Point to immediately before, within, or immediately after the file name, and issue the command (it'll give you a chance to tweak the name in the Minibuffer). In addition to filenames, it also handles URLs at Point via the Browse URL subsystem.

The command `M-x ffap-menu` will offer up for completion *all* the files and URLs mentioned in the current Buffer.[141]

If you *really* like `ffap`, you can invoke `ffap-bindings` in your Init File and it will remap 18 file-visiting commands (e.g. `C-x C-r` or `C-x 4 C-f`) to use `ffap`.

[140] The easier-to-type `ffap` is defined as an alias for `find-file-at-point`.

[141] Apparently I have 1,047 of them in this book at the moment (almost all URLs).

Persisting Files Across Sessions

You can arrange for the complete set of files you're currently editing to be restored when you exit and then restart Emacs. See *The Desktop*.

Large Files

When you visit a file, the entire contents of the file is loaded into memory. Modern computers have so much memory available that this is rarely an issue, but disk is still bigger than RAM, and you don't want your Emacs to slow down, much less be terminated by the operating system, because it uses too much memory.

When you visit a *large* file, Emacs will ask you to confirm that you really want to open it:

```
File Delicate Friction.zip is large (106.1 MiB), really open? (y)es or (n)o or (l)iterally
```

If you choose "(l)iterally", the file will be opened with `find-file-literally`. One of the problems with huge files is that syntax-highlighting may be slow; visiting the file literally will use fundamental mode and there won't be any syntax-highlighting to slow you down.

So what defines a "large" file? The variable `large-file-warning-threshold`. It's default value is a conservative 10,000,000 bytes; I recommend setting it to at least 100MB.

Init File

```
(setq large-file-warning-threshold (* 100 1024 1024)) ; 100MB
```

If you need to edit *truly* large files that won't fit in memory (say multiple gigabytes in size), you can do it with the VLF package. See *The Package Manager* for more information.

A related issue is files with extremely long lines, which can cause certain Major Modes to struggle. Files with such lines are typically

computer-generated and aren't usually intended to be edited by humans: things like minified Javascript or byte-code.[142] The solution to this problem is `global-so-long-mode`; it automatically switches buffers visiting files with long lines to `so-long-mode`, which handles them with no problem. I recommend it for your Init File:

[142] A typical minified Javascript file on my system is only 3M in size — not any kind of problem for my Emacs — but contains lines as long as 657,440 bytes.

Init File

```
(unless (version<= "29.1" emacs-version) ; no longer necessary!
  (when (version<= "27.1" emacs-version)  ; only available recently...
    (global-so-long-mode +1)))    ; speed up long lines
```

Saving Files

We've already mentioned the basic commands for saving files (really, saving Buffers): `C-x C-s` (`save-buffer`) and `C-x s` (`save-some-buffers`). You can additionally save an edited Buffer under a different file name with `C-x C-w` (`write-file`) (this effect is sticky: if you continue editing and then save with `C-x C-s` or `C-x s`, it will use the new name you chose). If you want to make a modified version of an existing file, rather than copying it first to a new name, you can just do `C-x C-f` and then immediately do `C-x C-w` to save it under the new name. To be clear, `C-x C-w` does *not* rename the file, but rather makes a new file with a new name.

You can also tell Emacs to ignore any modifications you've made to a Buffer, so that you don't accidentally save them to the file with a `C-x s` or an impulsive `C-x C-s`. Just use `M-~` (`not-modified`); after doing it, you'll notice that the modification asterisks `**` in the Mode Line have changed back to `--`, indicating the unmodified state, and Emacs won't ask you about saving this Buffer (until you modify it again).

Read-Only Buffers, or, Emacs is More

Emacs makes an excellent pager—i.e., a replacement for programs like `more(1)` and `less(1)`. Just do `C-x C-r` (`find-file-read-only`) (so that you don't accidentally modify the file) and now you can view the file and scroll and search through it.

Even better is to turn on the Minor Mode `M-x view-mode`, which makes the Buffer read-only (if it isn't already) and let's you page through it with `SPC` and backwards with `DEL`; it also redefines many printing characters to scroll by half-screenfuls, by lines, set marks and jump back to them, and many other things handy for browsing.

You can arrange to have `view-mode` turned on automatically whenever you make your Buffer read-only (which also happens if you visit a file that you don't have permission to edit). I recommend turning

this on in your init file:

Init File

```
(setq view-read-only t)
```

Reverting Buffers

We've all experienced the regret of making extensive changes to a Buffer, and then wishing we hadn't! If you change your mind about all the edits you've done since your last save, you might think you need to enter upon a long, tedious sequence of Undos until you get back to the unmodified version, or use `C-x k` (`kill-buffer`) and then revisit the file[143]. But really, all you need to do is ask Emacs to revert the buffer with `M-x revert-buffer` or the new command `C-x x g` (`revert-buffer-quick`): this means that Emacs will refresh the Buffer contents from the file on disk (`revert-buffer` will ask for confirmation), and you can then start over with your editing. Remember that if you made changes and *saved* them, then reverting can't undo the changes you saved; you need *Version Control* for that.[144] Note that, when you revert, this is the same exact Buffer, so if you've made any Buffer-local changes, they are preserved.

[143] I've even known people in this situation to exit Emacs, answer "no" to the "Save file?" question, and then restart!

[144] Actually, if you're not using Version Control, you can use your Backup file to recover an older version; the best way is via `M-x ediff-backup`.

You naturally can't revert Buffers that aren't visiting files. Or can you? Actually, many dynamic Application Buffers *can* be reverted! Examples include Buffers viewing web pages in the Web Browser (reverting reloads the page), Dired Buffers (reverting updates the Buffer to match the directory on disk), the Buffer Menu, and many more. You'll commonly find `revert-buffer` bound to `g` in Application Buffers.

Auto-Reverting (Watching Files)

Sometimes you want to visit a file that's regularly changing on disk. In `view-mode`, you can use `F` (`View-revert-buffer-scroll-page-forward`) to manually revert the Buffer from disk to see any updates, but you can also put a Buffer into `auto-revert-mode`, and Emacs will watch the file and automatically revert the Buffer whenever there's a change.

This is very handy when you're editing a LaTeX or Org Mode document and periodically generating a new PDF which you're viewing in `doc-view-mode` as you work (see *PDFs and Image Files*).

Log files are notable in that they are only appended to. You can use `auto-revert-mode` here, but a better choice is `auto-revert-tail-mode`, since it doesn't reload the entire (possibly huge) file every time: it just loads new lines from the end. (This is like the shell's `tail -f` command.)

Backup Files

Emacs never modifies your file on disk until you tell it to, but it's very careful about saving your work for you in a number of ways.

Backup files Emacs preserves the previous version of your file when you first save a file. If your file is named `foo`, the backup will be called `foo~` (note the tilde).

Backup files are, by default, stored in the same directory as the file being backed up, but you can arrange for the backups to go in a subdirectory, or in a completely different location, by Customizing `backup-directory-alist`.

Note that, by default, if your file is under version control, Emacs won't bother to make any kind of backup files, unless you tell it to (see `vc-make-backup-files`).[145] It also doesn't make backup files in temp directories (like `/tmp` on Unix systems). All these settings can be tweaked.

[145] Though it may sneak in a single backup file if you modify the new file before you add the file to the repo; you can delete this backup file once the file is checked-in and version control is managing it.

Numbered Backups You can also have Emacs make *numbered backups*, so that you can keep more than just the previous version. The oldest numbered backup file of the file `foo` would be named `foo~1~`; `foo~2~` would be newer, and the most recent is the one with the highest number (there's no limit to the number kept!). Numbered backups are off by default; you can set them as your default, but you can also manually rename any one backup file to it's numeric form:

```
M-x rename-file RET foo~ RET foo~1~ RET
```

and from that point on, Emacs will make numbered backups of that file (that is, until you delete all the backups; then it would start over with simple backups).

I don't recommend numbered backups; in general using your preferred version control system is much better practice, and Emacs has excellent VCS support.

Auto-Save Files

Emacs doesn't change a file's backup every time you save—only the first time since you started editing it; this is because most people Save Early and Often, hitting `C-x C-s` (`save-buffer`) frequently, and the backup file is your way of recovering from a long session of file changes.

So Emacs also, by default, auto-saves your file while you're editing it[146]; I think of these as *checkpoint* files. The auto-save file for a file `foo` is called `#foo#`. If Emacs (or the system) were to crash before you could save your edits, you could recover almost all of them from this file. Auto-saving happens (by default) every 300 characters you type, or every 30 seconds that you've been idle, or when a system error is encountered, whichever comes first. You can of course tweak these parameters if you're either more paranoid or over-confident.

[146] Even in a version-controlled or temp directory.

You can recover lost data by manually fiddling with the file and its contents from the auto-save file, but the simplest approach is just to visit the file you were editing and then say:

```
M-x recover-file
```

and, after a cautious confirmation dialog, Emacs will replace the contents of the Buffer with the auto-save file contents. In fact, if you visit a file which has an auto-save file which is newer than the file itself, Emacs will offer to do this recovery automatically.

If your entire session crashes (dropped connection to a remote host, laptop battery runs down) and you've been lazy about saving your work, you can fire up Emacs again and say:

```
M-x recover-session
```

and Emacs will walk you through the `recover-file` process for each file that needs it.

If you like to live dangerously, you can turn auto-saving off, but I really discourage this; there's no noticeable overhead and the auto-save file is deleted every time you do an explicit save with `C-x C-s`, so they don't clutter up your directories. I would also discourage the micro-management of exactly how auto-saving works which Emacs allows (EIPNIF). But see "Auto Save" in the *Emacs* manual for the gory details.

Lock Files

You can't (normally) edit two copies of the same file in the same Emacs, because of the way `C-x C-f` works, simply switching Buffers if you try to visit a file that's already loaded.[147] But what if you fire up two Emacsen and edit the same file in both? A recipe for disaster? Well, there's no need to worry as the two Emacsen will detect the conflict and notify you (but only if you try to modify the file when the other Emacs already has it modified). Emacs will ask:

[147] If you visit a symlink to a file you're already editing, Emacs will figure this out.

```
FILENAME locked by keith@krampus... (pid 290502): (s, q,p,?)?
```

If you type `s` you can "steal" the file from the other Emacs—this is safe; it just flips the roles of the two participants, and now if the other Emacs user tries to modify *their* Buffer, *they* will be the intruder and be asked the same question.

You can also type `q` to abandon the attempt, or type `p` to proceed into danger with no protection, if you insist.

Who are these "other users"? Nowadays, most computers, like your laptop, are effectively single-user systems (though all real operating systems support logins for multiple users), but when Emacs was born, few people had their own computer and instead worked together on the same mainframe or minicomputer via multiple hardware terminals: so file editing conflicts could occur.

But they can still occur on your single-user laptop: the other user is you, in a different terminal, or desktop, or the like. So lock files are still important.

Lock files are implemented (on Unix systems) as symbolic links and look something like this example (I mention this only in case you stumble upon one, and wonder what it is): `.#emacs-tutorial.org -> keith@krampus.1173283:1613350748`

Files Modified Behind Emacs's Back

Sometimes a file in your Emacs will be modified by some other process, behind Emacs's back. For example, you might synchronize files across multiple computers with an application like Syncthing, and thus you might change a file on your phone or desktop when you also have the file loaded in the Emacs on your laptop.[148] If you start to modify the Buffer (say, by typing in it), when the file has changed on disk, Emacs will ask:

[148] I hope you didn't use Vim in a terminal to make a quick change to that file…

```
FILENAME changed on disk; really edit the buffer? (y, n, r or C-h)
```

If you're not surprised at this (in the file synchronization case above, you probably won't be), you can type `r` to revert the Buffer.

If you *are* surprised, you can type `n` and your attempt to edit will be aborted; now you can investigate the situation. If you're lucky, you'll discover that you do indeed want the changes that were made on disk, and you can say `M-x revert-buffer` to refresh the contents of the Buffer and get back to work. (If you type `C-h` at the prompt, all these options will be summarized.)

If your Buffer was *already* modified in Emacs when the disk file got changed[149], then the question will be:

[149] Remember, save early and often!

```
FILENAME has changed since visited or saved.  Save anyway? (yes or no)
```

This is a much more annoying situation. If you proceed with your save, you will lose the changes on disk, but if you revert, you will

lose the changes in your Buffer! If you don't care about one of the two, you're okay: you can revert, throwing away your Buffer changes, or else save and allow the text currently in the Buffer to trump the contents on disk. But as Emacs says, "you risk ruining the work of whoever rewrote the file".[150]

[150] Remember, that other user is you!

If you want the best of both worlds, you'll need to combine the two versions. The solution in that case is `M-x ediff-current-file`, which uses the very powerful Ediff subsystem to let you merge changes in the disk file into your Buffer, and vice versa; see *Diffing and Merging*.

The cryptic Table 13 summarizes your options when your Buffer and your file are at odds. As in the Mode Line, `--` indicates *unmodified* and `**` indicates *modified*; `:-)` means we *want* the modifications, and `:-(` means we don't.

Buffer \ Disk	`--`	`** :-(`	`** :-)`
`--`	*(no conflict)*	`C-x C-w`[1]	`M-x revert-buffer`
`** :-)`	`C-x C-s`	`C-x C-s`[2]	`M-x ediff-current-file`
`** :-(`	`M-x revert-buffer`	`C-x k`[3]	`M-x revert-buffer`

Table 13: Resolving Modified Buffer vs File Conflicts

Notes:

1. We don't want the disk file content; since the Buffer's not modified, `C-x C-s` has nothing to save, but `C-x C-w` will write the Buffer out: just use the same filename.

2. We want the Buffer modifications, but don't want the disk file modifications. Since the Buffer *is* modified, `C-x C-s` will write it out, but you'll have to confirm that you really mean to clobber the modified disk file.

3. We want *neither* the Buffer modifications nor the disk file modifications. In this case, you should kill your unwanted modified Buffer, and use Version Control to recover the version of the file that you want.

Compressed Files

Emacs handles compressed files transparently. If you visit a file that's been compressed by any of the common Unix compression tools (compress, bzip2, gzip, lzip, lzma, xz, and zstd), it will be automatically uncompressed into the Buffer, and when you save it, the changed Buffer will be recompressed.[151]

[151] If Emacs isn't familiar with your favorite compression tool, you can customize the variable `jka-compr-compression-info-list`.

The Major Mode for a compressed file will be chosen in the usual way; the file extension used to choose the mode will be the one "underneath" the compression extension (e.g., a file `foo.org.bz2` will use `bzip2(1)` for the compression, but the Buffer will be in `org-mode`).

This is all actually handled by the Minor Mode `auto-compression-mode`, which is on globally (i.e. in all Buffers) by default. If you don't like this behavior, you can toggle the mode off as usual.

Encrypted Files

Emacs handles encrypted files in the same transparent manner that it handles compressed files. Unlike compression, there are not that many general-purpose encryption tools; Emacs only directly supports GNU Privacy Guard (GnuPG)[152] — see its manual. The default file extension is `.gpg`; if you visit an encrypted file with that extension, it will be decrypted into the Buffer, and when you save, it will be encrypted back to the file on disk.

[152] You'll need to install GnuPG from your operating system's package manager.

The Major Mode for an encrypted file Buffer will be chosen in the usual way based on the underlying file extension, if any, so `foo.org.gpg` will come up in `org-mode`.

This is all actually handled by the Minor Mode `auto-encryption-mode`, which is on globally (i.e. in all Buffers) by default. If you don't like this behavior, you can toggle the mode off as usual.

There are some differences compared to compressed files, of course. Emacs turns off `auto-save-mode` for the Buffer of an encrypted file, to avoid exposing your unencrypted text in a checkpoint file. Additionally, encrypting and decrypting a file requires you to specify a passphrase or key of some kind, for which you'll be prompted.

GnuPG is a complex program and you'll have to do some studying to really understand it. The most important concept is the distinction between *symmetric* and *public key* encryption. Public key has major advantages but requires some setup and preparation; you can easily do symmetric encryption without any. See *EasyPG Assistant* for more information on Emacs GnuPG integration.

Archive Files

You can also directly edit archive files, like tar files; 7z, ar, arc, lzh, lzh-exe, rar, rar-exe, squashfs, squashfs, zip, and zoo archives; and all types of OpenDocument files (word processing, spreadsheet, presentation, graphics, and formula files) and EPUBs, which are stored as ZIP archives containing multiple parts. The interface has many similarities to Dired.

When you visit an archive, you are shown what looks like the table of contents listing of that archive format. Here's the Buffer contents I see when I visit the tar archive for one of my Emacs packages via `C-x C-f refer-mode-1.18.0.tar`:

```
drwxr-xr-x   keith/keith         0 refer-mode-1.18.0/
-rw-r--r--   keith/keith        72 refer-mode-1.18.0/refer-mode-pkg.el
-rw-r--r--   keith/keith       612 refer-mode-1.18.0/dir
-rw-r--r--   keith/keith     50555 refer-mode-1.18.0/refer-mode.el
-rw-r--r--   keith/keith     30243 refer-mode-1.18.0/refer-mode.info
-rw-r--r--   keith/keith       437 refer-mode-1.18.0/README
```

Note that the Mode Line will show the size of visible Buffer text, which is what it always does (see, for example, Narrowing), but this is deceiving. For the above tar file, the Mode Line says the Buffer contains 384 *bytes*, but Emacs really has loaded the entire tar file into memory, and its size is actually 92K. I mention this just because it's not unusual for archive files to be very large. If you try to visit a really big archive, you'll get the *large file warning*, to make sure you really want to do it.

Via the Buffer of an archive file, you can edit any of the component files transparently. Just position Point on the desired file's line and hit `e`, `f`, or `RET`[153] You'll now be in a Buffer containing the contents of that file; the Buffer name in the Mode Line will be something like `refer-mode.info (refer-mode-1.18.0.tar)`.

[153] In this `tar-mode` buffer, that's `tar-extract`; it'll be an analogous function for another type of archive.

You can edit at will using all the features of Emacs; when you save the Buffer, the edited contents will replace that file in the archive—*but only in the archive Buffer*: the archive file on disk won't be modified until you save the archive Buffer itself. So fully saving a file from an archive is a two step process: save the file, then save the archive containing it. When you save the Buffer of the component file, you'll see a message like this one in the Echo Area:

```
Saved into tar-buffer 'refer-mode-1.18.0.tar'.  Be sure to save that buffer!
```

In addition to editing the archive contents, you can manipulate the archive itself. You can delete, rename, or change the owner, group, or mode of any of the component files. You can copy a file out of the archive to the disk, and you can add a new file to the archive (you'll get a new empty Buffer to which you can add content). In the archive Buffer, just do the usual `C-h m` (`describe-mode`) or hit `?` for help; see "File Archives" in the *Emacs* manual.

Many archive formats implement their own compression scheme, but tar archives don't; they are usually compressed by any of the standard Unix compression programs (like `gzip(1)` or `bzip(1)`); `tar-mode` works on compressed tar archives, too.

Most of the other archive formats support the same kinds of operations, with the same key bindings, but there are a few lacunae (in particular, not all the other archive formats support changing owner, group, or mode—probably because these are Unix concepts and some of the other archive formats were developed on MS Windows).

Emacs's support for tar files is fully implemented in Elisp, so you don't need to have a `tar(1)` program installed, but the other archive formats require the appropriate program to be installed as a helper.

Document Files (PDFs and the Like)

Emacs can display various types of formatted documents, in particular, PDFs[154], OpenDocument (and older Microsoft Office) files, EPUB e-books, PostScript, and DVI files. (Since most of these documents aren't plain text, Emacs needs to be running in graphical mode to display them; otherwise it will necessarily fall back to a degraded view.)

[154] There is a 3rd-party Emacs package available in Melpa-Stable called PDF Tools that provides enhanced handling of PDFs; see below.

All of these file types require some supporting non-Emacs software to be installed via your operating system's package manager; see Table 14.

Format	Requires
PDF	MuPDF[155]or GhostScript
EPUB	UnZip *and* (optionally) `nov`[156]
OpenDocument, `.docx`	UnZip, unoconv *and* GhostScript
PostScript	GhostScript
DVI	GhostScript or TEX Live
Microsoft `.doc`	unoconv

Table 14: Prerequisite Software for Document Viewing

[155] MuPDF does a better job on PDFs than GhostScript, so its a good idea to install it even if you already have GhostScript installed.

[156] `nov` is a 3rd-party Emacs package available from the Melpa-Stable repository.

All of these document types are handled by `doc-view-mode`, which provides scrolling and paging commands (somewhat similar to `view-mode`); see Table 15.

Key	Action
`RET`, `C-n`, `<down>`	scroll one line forward (or next page)
`C-p`, `<up>`	scroll one line backward (or previous page)
`SPC`	scroll one window forward (or next page)
`DEL`, `S-SPC`	scroll one window backward (or previous page)
`n`, `<next>`	go to Next page
`p`, `<prior>`	go to Previous page
`<`	go to top of page
`>`	go to bottom of page
`M-<`	go to beginning of document
`M->`	go to end of document

Table 15: `doc-view-mode` Scrolling and Paging Commands

There are six commands to change the size of the page text:

- `P` assure full Page is visible in window
- `H` assure full Height is visible in window
- `W` assure full Width is visible in window
- `+` enlarge the page text
- `-` shrink the page text
- `0` reset the page text size

If the document you're viewing is one that you're also authoring (say in LATEX, `org-mode`, or some other markup language), you can

update it after you've made changes by reverting the Buffer with the `g` (`revert-buffer`) command (or equivalently, `r`). But I recommend using `M-x auto-revert-mode` (see *Reverting Buffers*); you can add this snippet to your init file to make it your default for `doc-view-mode`:

Init File

```
(add-hook 'doc-view-mode-hook 'auto-revert-mode)
```

Toggling the Display Mode

All these document formats have an underlying encoding. PostScript and PDF files really have a plain-text encoding; DVIs have a binary encoding, and EPUBs and OpenDocument files are Zip archives that contain several files in a variety of formats. The point being, you might want to view the underlying encoding, the *raw* data, rather than view the document. The command `C-c C-c` (`doc-view-toggle-display`) will toggle back and forth between the two views.[157]

[157] In an EPUB's `nov-mode`, the command for this is `a` (`nov-reopen-as-archive`).

Just the Text, Please

Viewing "documents" may sometimes be necessary, and even superficially attractive, but it clashes with the very nature of Emacs as a plain-text engine. These documents are basically images, and the more you have to deal with them, the more you'll miss the ability to use keyboard macros, powerful searching, textual objects, and all the rest of the synergistic power that Emacs provides. This can be mitigated somewhat with `C-c C-t` (`doc-view-open-text`), which toggles the Buffer to a plain-text version of the document, where you can use all your powers. `C-c C-c` (`doc-view-toggle-display`) will toggle back to the graphical view.

Searching

Searching in `doc-view-mode` is awkward compared to searching in plain text Buffers because it can't highlight the matched hits the way `isearch-forward` does[158]. `C-s` (`doc-view-search`) does a regular expression search forward, but since it can't highlight the hits, it simply reports the number of hits in the Minibuffer with a message like "DocView: search yielded 5 matches." Now hit `C-s` again to jump to the page with the first hit. Subsequent `C-s`'s advance to further pages with hits. To initiate a brand new search (with a prompt for a new regexp), use `C-u C-s`. The same procedure works backwards with `C-r` (`doc-view-search-backward`).

[158] But PDF Tools can.

This is obviously a little sad, as it can be tricky to spot matches in a page. One solution for arbitrary document formats is to switch to text mode with `C-c C-t` and do your search there. I find this pretty satisfactory, really.

Additionally, after you've initiated a search and moved to a given page of hits, you can pop up a GUI *tooltip* window that lists all the hits on the page with some context by hitting `C-t` (`doc-view-show-tooltip`).

But for PDFs, PDF Tools implements incremental search in a completely normal manner, with highlighting of the hits in the graphical view. Highly recommended.

Slicing

Since graphical documents are fundamentally designed with print in mind, they often have a large amount of whitespace around their edges, sometimes excessive amounts (I'm looking at you, default LaTeX format...). A more compact view with minimal borders can be achieved with the *slicing* commands. Easiest to use is `s b` (`doc-view-set-slice-from-bounding-box`) which does the slice automatically; you can also manually set the slice with the mouse after executing `s m` (`doc-view-set-slice-using-mouse`). To restore the whitespace, invoke `s r` (`doc-view-reset-slice`).

Better PDF Handling with PDF Tools

If you install the 3rd-party package `pdf-tools`, you will have a much-enhanced version of `doc-view-mode` for PDFs (only). It requires you to install the external package `poppler` from your OS package manager.

Some of its advantages are that pages are rendered into memory on the fly[159]; it has a true incremental search with highlighted hits in the graphical view and even has `M-x occur`; you can follow links; make and view annotations; manipulate attachments; and display a document outline (table of contents).

`C-c C-c` will toggle between `pdf-view-mode` and `doc-view-mode`; there are a few things PDF Tools can't do that `doc-view-mode` can.

I recommend `auto-revert-mode` for `pdf-view-mode` also:

Init File

```
(add-hook 'pdf-view-mode-hook 'auto-revert-mode)
```

[159] `doc-view-mode` renders all the pages at once into temporary files (though it pops up the first page as soon it's ready).

Image Files

You can view image files (Emacs knows dozens of formats) as well as document files. Just visit an image file and it will be displayed (only in a graphical mode Emacs, of course). There are two non-graphical displays: `C-c C-c` (`image-toggle-display`) toggles between graphical and the raw underlying bytes (you'll be in `fundamental-mode`),

while `C-c C-x` (`image-toggle-hex-display`) will switch to a hex-dump display of the raw data (see *Binary Data Files*).

Browsing Images

While viewing an image in `image-mode`, you can visit the next image file[160] in the same directory with `n` (`image-next-file`); `p` (`image-previous-file`) goes the other way; these commands reuse the same Buffer and Window and so don't fill your Emacs with image Buffers. `w` (`image-mode-copy-file-name-as-kill`) will copy the absolute pathname of the image you're viewing to the Kill Ring.

[160] In alphabetical order.

You can also mark images with `m` (`image-mode-mark-file`) so that you can define a collection of files for later manipulation. This works by setting marks in the Dired Buffer of the image directory[161]; when you're done, you can switch to the Dired Buffer and do, well, anything: change permissions, tar or zip up the files into an archive, copy or mass rename the files, or use Tramp to upload the files to another machine. Dired also has two modes for viewing thumbnails of image files.

[161] The Dired Buffer will be opened automatically in the background if you don't already have one.

Resizing Images and Animations

When you visit a file it will be resized to fit the Window. If you resize the Window, by default the image will be resized with it. There are several commands for explicitly scaling the image; if you do this, the automatic resizing when the Window size changes will be disabled until you reset the image size with `s 0`; see Table 16.

Keys	Action
`s h`	Show full Height in window
`s w`	Show full Width in window
`s b`	Show Both full height and width in window
`s o`	Show image unscaled at Original size
`s 0`	reset image scaling to auto
`RET`	start or stop animating the current image[162]

Table 16: `image-mode` Scaling Commands

[162] If it's an animated GIF.

If you set the image to its original, unscaled, size, you can scroll it in the Window with most of the usual `view-mode` motion and scrolling commands; see Table 17.

Key	Action
SPC	scroll image up
DEL, S-SPC	scroll image down
C-b, <left>	scroll image left
C-f, <right>	scroll image right

Table 17: `image-mode` Scrolling Commands

Binary Data Files

We've just seen that, while Emacs is primarily a plain-text engine, it has helpful modes for displaying graphical data files like images and formatted documents. Most graphical data files are actually *binary data*[163], i.e., a sequence of arbitrary bytes not intended to be interpreted as characters — letters, digits, punctuation — in any particular character set[164]. There are many other types of binary data files, including compiled executable programs, database files, audio files, and so on. You may never need to view this raw data (unless you're a programmer or system administrator), but if you do, Emacs is ready.

[163] But not all: consider SVG.

[164] Or as Emacs calls it, *coding system*.

If you visit a binary data file for which Emacs doesn't have a special Major Mode defined, it will come up in `fundamental-mode`, and you'll be looking at the raw bytes. Here's what the beginning of an MP3 file from my collection looks like:

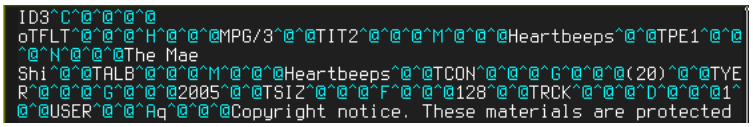


Figure 26: The Mae Shi's *Heartbeeps* in `fundamental-mode`

(See *What Is Text?* for an explanation of the cyan characters.) You can see, for example, that the MP3 format allows for text in the audio file (these are ID3 tags for metadata). Emacs supports a friendlier or at least more traditional format for displaying binary data, called a *hex dump*, via `M-x hexl-mode`—Figure 27 shows the beginning of the same file in `hexl-mode`:

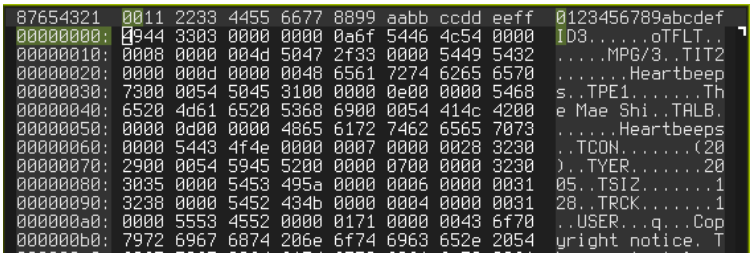


Figure 27: The Mae Shi's *Heartbeeps* in `hexl-mode`

(If you know you're visiting a binary file you can skip the mode-change via the shortcut `M-x hexl-find-file`.) As with many alternative-display modes, you can switch back to the previous Major Mode with `C-c C-c`.

All the usual motion commands work appropriately in `hexl-mode`, and you can modify the Buffer by typing self-inserting characters (`hexl-mode` also has a number of other ways to insert bytes — but either way, make sure you know what you're doing).

Note that because many binary data formats contain fixed-length sections and have alignment restrictions[165], `hexl-mode` puts the Buffer in `overwrite-mode` (you can change that if you know what you're doing). If you're going to edit binary data in `fundamental-mode`, you probably want to turn on `binary-overwrite-mode` for the same reason.

[165] Which is what makes the addresses along the top and the left of the hex dump display so useful.

Editing binary files is only for Real Programmers and not the faint of heart, but if you have to do it, it actually *works* in Emacs: which is to say, it *won't* work in many other editors, which may corrupt the file when you save it (say by deleting or adding white space or helpfully converting assumed-character sets). What you see in the Buffer in `fundamental-mode` or `hexl-mode` in Emacs is exactly what will get written to disk.

UNFINISHED *Quoting File Names*

UNFINISHED *Filesets*

References

- Ashley, Mike. 1999. *The GNU Privacy Handbook.* Cambridge, MA: Free Software Foundation. `https://www.gnupg.org/documentation/guides.html`.
- Free Software Foundation. 2017. *The GNU Privacy Guard Manual.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET gnupg RET`.
- Post, Ed. July 1983. "Real Programmers Don't Use Pascal." *Datamation*. `https://www.ee.ryerson.ca/~elf/hack/realmen.html`.

Directory Editing with Dired

Emacs is thought by the uninitiated to be a (mere) text editor, so of course it can edit files. But it can also edit directories ("folders" to some). What does it mean to "edit" a directory? It means to do the sorts of things that are normally done with Unix shell commands (like `cp(1)`, `rm(1)`, or `chmod(1)`) or a file manager, like Windows Explorer (File Explorer), Apple's macOS Finder, or the venerable Norton Commander and its Unix clone, Midnight Commander.

Emacs handles directories via a special Major Mode, `dired-mode` (Dired for short). Dired was one the first file managers, having existed in ITS TECO Emacs since at least 1978. Dired is to files what Buffer Menu is to Buffers.

To invoke Dired, just visit a directory, rather than a file, with `C-x C-f` (`find-file`) or any other file-visiting command. (Make sure your completion system doesn't instead helpfully choose a filename within that directory.) You can also invoke Dired directly with `C-x d` (`dired`). The result will be a Buffer that looks like the output of the Unix `ls(1)` command with its `-l` option[166]. Here's the source code directory of one of my Emacs packages:

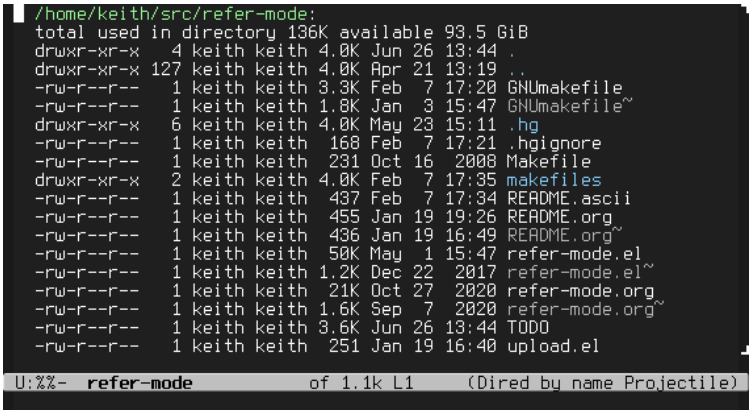


Figure 28: `C-x d` (M-x dired)

[166] On Microsoft Windows, where `ls(1)` doesn't normally exist, Emacs emulates it in Elisp.

This is *not* the same as the result of `M-!` (`shell-command`) `ls -l ~/src/refer-mode` which would look superficially similar; nor is it the same as `M-x list-directory`. For one thing Dired has colorized

some of the filenames, but most importantly, rather than being in `fundamental-mode`, the Dired Buffer is in `dired-mode`.

In `dired-mode` you can of course move around in and search the Buffer with all the usual commands you already know, but the Buffer is read-only so you can't modify it[167], and many printing characters are bound to useful commands for manipulating the files. For example, if you move Point to any of the lines representing a file, then hitting `RET` invokes `dired-find-file` and visits that file in a new Buffer.

[167] But see *Writable Dired*, below.

Dired is even more useful with the many enhancements from the Dired Extra package. I recommend adding this to your Init File:

Init File

```
(add-hook 'dired-load-hook (lambda () (require 'dired-x)))
```

and this chapter will assume you have done so.

Basic File Operations

Table 18 lists some of the basic Dired file operations; the Unix column gives roughly analogous shell commands. All the commands operate on the file named on the current line — you don't have to have Point precisely on the filename part of the line. Some of the commands operate immediately (e.g., the file visiting commands), but most will either ask for confirmation or for additional information. `C` will ask for the name of the new, copied, file; `M` will ask for the new file mode; `D` will ask if you're sure you want to delete the file, and so on.

Most of these commands can be applied to multiple files; see below.

Subdirectories

Inevitably some of the files in your Dired Buffer will be directories themselves (initially at least, every Dired Buffer will contain the standard Unix `.` and `..` directories). There are two ways to work with the contents of a subdirectory:

- open it in its own Dired Buffer (just use any of the Dired file visiting commands such as `RET`, `e` `f`, `o`, or `a`), or
- insert (expand) its contents into the current Dired Buffer with `i` (`dired-maybe-insert-subdir`).

Both approaches have merit. I usually prefer inserting unless I want to start working in two-panel mode with Dired DWIM.

When you insert a subdir, it looks much like it does when you run `ls -lR`. Here I've issued the `i` command from the `makefiles` line:

Table 18: Basic `dired` File Operations

Key	Unix	Action
`RET`, `e`, `f`	`cat`	visit (Edit, Find) this line's file
`a`		... and clobber Dired buffer
`o`		... in other window
`v`	`more`, `less`	... in `view-mode`
`^`	`ls ..`	open Dired on the parent of this directory
`F`		visit *all* marked files
`C`	`cp`	Copy file
`c`	`tar -cZ`	Compress files into a `tar` archive
`D`	`rm`	Delete file
`G`	`chgrp`	change Group
`H`	`ln`	make Hardlink to this file
`i`		insert this subdirectory into Dired
`k`		vanish ("Kill") marked lines (*not* files)
`M`	`chmod`	change Mode (permissions)
`O`	`chown`	change Ownership
`P`	`lpr`	Print file
`R`	`mv`	Rename file
`S`	`ln -s`	make *absolute* Symlink to this file
`T`	`touch`	update file's Timestamp
`Y`	`ln -s`	make *relative* symlink to this file
`w`		copy this file's basename to the kill ring
`0 w`		... absolute pathname
`C-u w`		... relative filename
`W`	`firefox`	view this presumably HTML file in your Web browser
`Z`	`gzip`, `tar`	(un)compress and/or (un)tar this file
`=`	`diff`	compare this file to another
`+`	`mkdir -p`	create a new subdirectory
`!`, `X`, `&`		run shell command on file (see below)
`?`		1-line help or describe errors
`B`		Byte-compile elisp files
`L`		Load elisp files into Emacs
`: d`		Decrypt file
`: e`		Encrypt file
`: s`		Sign file
`: v`		Verify signature

```
-rw-r--r--   1 keith keith  231 Oct 16  2008 Makefile
drwxr-xr-x   2 keith keith 4.0K Jun 29 13:29 makefiles
-rw-r--r--   1 keith keith  437 Feb  7 17:34 README.ascii

/home/keith/src/refer-mode/makefiles:
total used in directory 28K available 93.5 GiB
drwxr-xr-x 2 keith keith 4.0K Jun 29 13:29 .
drwxr-xr-x 4 keith keith 4.0K Jun 30 13:07 ..
-rw-r--r-- 1 keith keith  290 Jan 19 17:15 Makefile.gnumake
-rw-r--r-- 1 keith keith 1.2K Jan 19 17:18 Makefile.help
-rw-r--r-- 1 keith keith 1.2K Feb  7 17:35 Makefile.org
```

(If you type `i` on a non-directory, it's an error; if you type it on a directory that's already inserted, Point will jump to the first file in that subdirectory.)

The subdirectory header lines — e.g. `/home/keith/src/refer-mode/makefiles:` in the above — support some special actions. Typing `l` (`dired-do-redisplay`) on one of these lines updates the contents, so that a file newly created (by some other program) in the subdirectory will appear, deleted files disappear, and any changes to file sizes, permissions, etc, will also be updated. `$` (`dired-hide-subdir`) will toggle the visibility of the contents of the subdir, leaving the header line.

< and > move Point from directory file to directory file in the Buffer, and the usual list-motion key bindings (`C-M-n`, `C-M-p`, `C-M-u`, `C-M-d`) move in terms of inserted directory header lines.

When any subdirectories are inserted, all the files visible in them can be manipulated along with all the files in the directory proper; this includes all the file marking commands discussed below.

Compressing and Archiving Files

`Z` (`dired-do-compress`) is somewhat special. If applied to a single regular file, or several marked files, it compresses or uncompresses them, based on the file extension[168].

If applied to a directory (a subdirectory of the Dired Buffer, which includes the `.` and `..` entries), `Z` creates a compressed tar archive of all the files in that directory[169]. If applied to an archive file, the `Z` command will extract its contents. Dired knows some 17 compression and archive types.

Dired is the easiest way I know to create a tar archive containing a precise and arbitrary set of files. It's easy to tar up a directory of files from the shell with `tar cvzf archive.tar.gz some-directory`. But what if you only want a subset of the files in `some-directory`? Maybe just the `.mp3` files but not the `.jpg` and `.pdf` files, but including the `README.txt`? You can carefully list all the files to be included on

[168] For the compression case, `gzip` is used.

[169] If that tar archive already exists, it is updated so that its contents match the current state of the subdirectory.

the command line: pretty tedious! Or use tar's `--exclude` option, but that's going to be even more tedious if there are lots of files to exclude.

With Dired, it's easy. Just use the powerful file marking commands to select exactly the files you want, and then invoke `C` (`dired-do-compress-to`), and the tar file will contain exactly the files you marked.

Deleting Files by Flagging

In addition to `D` (`dired-do-delete`), which deletes the current file, you can take a more thoughtful approach to cleaning up a directory by *flagging* a set of files for deletion, and then, after suitable contemplation, delete them all. The command `d` (`dired-flag-file-deletion`), rather than deleting a file, sets the `D` flag in the Dired Buffer; here I've typed `d` on all the squiggle-file (backup file) lines:

```
D -rw-r--r--   1 keith keith  436 Jan 19 16:49 README.org~
  -rw-r--r--   1 keith keith  50K May  1 15:47 refer-mode.el
D -rw-r--r--   1 keith keith 1.2K Dec 22  2017 refer-mode.el~
  -rw-r--r--   1 keith keith  21K Jun 28 15:30 refer-mode.org
D -rw-r--r--   1 keith keith 1.6K Sep  7  2020 refer-mode.org~
```

If you change your mind about any of them, you can undo the flag with `u` (`dired-unmark`). When you're ready, you can actually *execute* all the deletions with `x` (`dired-do-flagged-delete`). The confirmation prompt will clearly list all the files about to be deleted to help avoid tragic mistakes.[170]

For more convenience in cleanup, `~` (`dired-flag-backup-files`) will mark all backup files, and the command `% &` (`dired-flag-garbage-files`) will add `D` flags to all the files that look like "garbage"[171] and `% d` (`dired-flag-files-regexp`) will flag all files whose names match a regular expression.

The flagging commands—`d` and its friends—are actually a special case of the general Dired concept of *marking*.

[170] This double confirmation of mass deletes really appeals to my paranoid nature.

[171] By default, LaTeX detritus; you can customize `dired-garbage-files-regexp` and add your own detritus.

Marking Files

When manipulating files in the shell, you can use wildcards (*glob* characters) to handle multiple files at once. Dired itself doesn't support wildcards, but it has a few (superior) tricks up its sleeve.

Most of the basic commands in Table 18 take a numeric argument; given an argument of N, the command will be applied to the next N files. So `C-u 2 D` will delete the file on the current line and the file on the line after it. `dired-mode` is descended from `special-mode` and like most Special Modes, you can use the digits alone as numeric arguments, so just plain `2 D` is equivalent.

However, this is really only ever used for a very small number of files, like two or three, because having to count is both annoying and error-prone. On top of that, the files you want to operate on might not be contiguous! The solution is to *mark* the set of files of interest.

We saw above how the `d` command *flags* files for deletion, but Dired also has a general purpose mark, spelled `*`. You can apply this mark to any file or directory (and advance Point to the next file) with `m` (`dired-mark`); `u` (`dired-unmark`) will remove the mark on the current line and advance (`DEL` unmarks and moves in reverse), and `U` (`dired-unmark-all-marks`) will remove all the marks *and* flags in the Dired Buffer. `m` itself takes a numeric argument; or, if the Region is activated, will mark all the files within it. Finally, if you hit `m` on an expanded subdirectory header line, it will mark all the files within that directory (if you hit `m` on a directory proper, it only marks that directory filename). Here I've marked two `README` files; in addition to the `*` mark, the filenames are colored a bold orange:

```
  drwxr-xr-x   2 keith keith 4.0K Jun 29 13:29 makefiles
* -rw-r-r-   1 keith keith  437 Feb  7 17:34 README.ascii
* -rw-r-r-   1 keith keith  455 Jan 19 19:26 README.org
  -rw-r-r-   1 keith keith  436 Jan 19 16:49 README.org~
```

Sometimes it would be easier to mark the files you're *not* interested in, rather than those you are. Just mark the uninteresting files and hit `t` (`dired-toggle-marks`), and the marks will all flip. The easiest way to mark *all* the files in the Dired Buffer is to hit `t` when no files are marked (you can always achieve that state with `U`, or can memorize the sequence `U t` as "mark all files").

You can move from marked file to marked file with `M-}` (`dired-next-marked-file`) and `M-{` (`dired-prev-marked-file`).

When there are `*` marks in the Buffer, most of the basic Dired commands will operate on all the marked files, instead of on the current line.[172] So to copy 10 files to a different directory, just mark the files and say `C`. Some commands have to make specific interpretations in the presence of marks, or may ignore them if they just don't make sense.

Some Dired commands will add their own special marks to files. The `C` command adds a `C` mark to the new file that just got created by the copy; the `H` command will likewise add an `H` mark and the `S` and `Y` commands an `S` mark to the new files they create[173]. Here's part of my Dired Buffer after I've copied (with the `C` command) the `upload.el` file to the name `Y`, hard-linked it to `X` with the `H` command, and relatively-symlinked it to `Z` (with the `Y` command). That's three new files that weren't in the directory (and hence weren't in the Dired Buffer) previously.

[172] You can override this by giving a command a numeric argument of `1`, which will force it to operate on the current line (actually any numeric argument overrides the marks and operates on the given number of files at Point).

[173] This is assuming that the new files are visible in some Dired buffer. You won't see any marks if you can't see the new files.

```
  -rw-r--r--   1 keith keith 3.6K Jun 26 13:44 TODO
H -rw-r--r--   2 keith keith  251 Jan 19 16:40 X
S lrwxrwxrwx   1 keith keith    9 Jun 28 15:02 Z -> upload.el
C -rw-r--r--   1 keith keith  251 Jan 19 16:40 Y
  -rw-r--r--   2 keith keith  251 Jan 19 16:40 upload.el
```

These marks serve as an indicator that the operations were done and these files won't be affected by any commands operating on the standard `*` or `D` marks that may be in the Buffer. But they aren't just cosmetic.

Suppose you make copies of 10 files. All the copies will be marked with the `C` mark. Now perhaps you want to change the file permissions of the copied files to read-only. Just change the `C` marks to `*` marks with `* c` (`dired-change-marks`) and now `M` (`dired-do-chmod`) will change the modes of the 10 copied files.

The Mark Keymap

Manually marking files with `m` may not seem like any competition for shell glob patterns, so Dired has a whole slew of commands to make marking multiple files easier; they can be found on the `*`-prefix key in `dired-mode`; see Table 19.

Table 19: The Dired Mark Keymap

Key	Action
`* *`	mark all executable files
`* /`	mark all directories
`* @`	mark all files that are symlinks
`* .`	mark all files with a given file extension
`* %`	mark all files matching a regexp
`* s`	mark all files in the current Subdirectory
`* O`	mark all Omitted files
`* c`	Change all given marks to some other mark
`* N`	display Number of marked files

If you're familiar with the `ls(1)` command's `-F` (`--classify`) option, the mnemonics for `* *`, `* /` and `* @` will be obvious. `* %`'s mnemonic is that Dired has a `%` prefix full of regexp operations.

Issue any of these marking commands and the matching files will be marked with `*`'s. You can combine several of them, and also mix in `t`, `m` and `u` commands until you've got exactly the combination of files you want.

All of these marking commands will instead *unmark* if given a prefix argument via `C-u` (`universal-argument`).

Why is there no command to mark plain files, i.e., non-directory files? That seems like an oversight! The reason is that you can achieve that effect in several ways: you can mark *all* the files with `U t` and

then say `C-u * /` to unmark the directories, or you can unmark all with `U`, mark the directories with `* /`, and then toggle the marks with `t`.

`* N` (`dired-number-of-marked-files`) is a little out of place in the `*` Keymap, in that it doesn't mark any files, but it's a handy command that will display in the Echo Area the number of marked files and their total size.

Mass Name Changes by Regular Expression

A classic file management problem that was left unsolved by the founding fathers of Unix (Ken, Dennis, Brian, *et al.*) is operating on many files while changing their names according to some pattern: for example, copying a bunch of files but adding a `.bak` extension, renaming files to their lowercase equivalents, and the like. People used to resort to verbose and error-prone shell for-loops or scripts involving `sed(1)` or `perl(1)`, and a number of special-purpose utilities have appeared over the years to address this need (such as `rename(1)`, `mmv(1)`, `zsh(1)`'s `zmv`), but how to do it is still a popular query in the search engines.

Dired provides a suite of commands to handle this, on the `%` prefix (mnemonic: kind of like `C-M-%` (`query-replace-regexp`)); see Table 20.

Table 20: Dired by Regular Expression

Key	Action
`% R`, `% r`	Rename files with new names
`% l`	rename files to Lowercase equivalents
`% u`	rename files to Uppercase equivalents
`% C`	Copy files with new names
`% H`	Hardlink files with new names
`% S`	Symlink files with new names
`% Y`	symlink files relatively with new names
`% m`	Mark files that Match regexp
`% g`	mark files *containing* regexp matches

Note that for all these commands, we are using Emacs regular expressions, *not* shell wildcard (glob) patterns!

The exemplar for all these commands is `% R` (`dired-do-rename-regexp`). Suppose we want to rename the two files `README.ascii` and `README.org` to `about.ascii` and `about.org` — in other words, we want to change the `README` part of each filename to `about`, preserving any other parts of the filenames (such as, the extensions).

First, we have to mark the two `README` files, and then invoke `% R`.[174] The prompts go as follows:

```
Rename from (regexp): README
```

[174] Or, if they happen to be contiguous in this directory, we can put Point on the first and say `2 % R`.

```
Rename README to: about
```

and now we start renaming:

```
Rename 'README.ascii' to 'about.ascii'? [Type yn!q or C-h]
```

This prompt is similar in spirit to the way `query-replace-regexp` works:

`y` or `SPC`	to perform this renaming
`n` or `DEL`	to skip to the next renaming
`!`	to perform this and all renamings with no questions
`q`	skip this renaming and quit
`C-h`	explain these options

If we don't choose `!` or `q`, then we'll be asked the same question about each of the remaining files:

```
Rename 'README.org'   to 'about.org'?   [Type yn!q or C-h]
```

You need to be familiar with regular expressions to do fancier stuff[175]; for example, we can add a `.bak` extension to a set of files by specifying `$` as the from regexp and `.bak` as the replacement (because `$` is the regexp that matches the end of any filename).

[175] But then you really need to be familiar with regexps to be an Emacs (or Unix) user.

Note that the regexp is only applied to the *basename* of the file — e.g. `README.org` not `/home/keith/src/refer-mode/README.org`. If you give any of these commands a `0` numeric argument, then the regexp *is* applied to the absolute pathname, and you can then modify the directory structure as well.

`% l` and `% u` are convenient ways to do a simple case transformation on the entire basename of the file (including the extension if any).

The `% C`, `% H`, `% S`, and `% Y` commands work like `% R`, *mutatis mutandis*.

Finally, we have two commands that merely mark files (with no action) based on regular expressions. They consider all the files in the Buffer and mark the ones that match. `% m` (also available as `* %`) just does the match based on the file basename, so `% m x` would mark all files whose names contain the letter `x`.

`% g` is just like `% m` except that it applies the regexp to the *complete contents* of the files, rather than to their names. It marks all the files that contain a match for the regexp. Think of it as the Grep of marking commands.

If you give either of these last two commands a prefix argument, they *unmark*, instead of marking.

What Went Wrong?

We've learned a number of useful file manipulation commands, but we have to face the fact that sometimes, some of them are going to fail. Errors in Emacs are usually simple: you hear a beep and there's a message in the Echo Area telling you what went wrong. But if you're having Dired act on several, even hundreds, of files in one stroke, you neither want to miss an error, nor be swamped by too many.

Suppose we try to copy a bunch of files to a different directory, but it turns out we don't have permission. Dired will display a message like this:

```
Copy: 17 of 17 files failed--type ? for details ((refer-mode.org README.org ...))
```

and we can use `?` to pop up the `*Dired log*` Buffer for a complete record of which operations failed (and why); in this case we'd see lines like:

```
Thu Jul  1 11:58:13 2021 Buffer 'refer-mode'

Copy: '/home/keith/src/refer-mode/GNUmakefile' to '/etc/GNUmakefile' failed:
(file-error Opening output file Permission denied /etc/GNUmakefile)
```

Writable Dired

Dired Buffers are read-only Buffers, so that you can't accidentally corrupt the contents and confuse Dired. What if you edited the name of one of the files and then tried to operate on it? You'd get errors.

On the other hand, what if, when you edited the name of a file, it magically renamed the file to the new name? That would be an easy and natural way to rename files. More importantly, it would allow you to rename files using all your Emacs skills: use `M-l` (`downcase-word`) to change part of a filename to lowercase; use `M-%` (`query-replace`), `C-M-%` (`query-replace-regexp`), or Rectangle commands to mass-rename a set of files without needing to mark them: even use a Keyboard Macro!

This is exactly what Wdired allows. You simply switch the Dired Buffer from the default read-only mode with the natural keystroke `C-x C-q` (`dired-toggle-read-only`) which you'll recall normally toggles `read-only-mode` on and off. The Mode indicator in the Modeline will change to `Editable Dired`, and now you can change filenames via whatever means you like. You can even change a file name like `foo.org` to `/tmp/foo.org` to move it to a different directory; you can use relative or absolute paths for this, and Dired will create new subdirectories as needed!

The changes don't happen instantly, so you can take your time; edit one filename, think about things, and edit another. Maybe then change one of them back (with Undo if you like!). When you're done with your changes, you *commit* them with `C-c C-c` and then all your renames happen at once[176]; the Buffer is then restored to the normal read-only `dired-mode`. If you experience Renamer's Remorse, you can instead cancel all your changes with `C-c ESC`.[177]

But there's more. If you have a symlink, you can edit either the symlink name, its target, or both. If you kill or delete a filename completely, the file will be deleted.[178] And if you edit the permission string of a file, it will be `chmod`'ed (so you could remove the write permissions on a file by editing `-rw-r--r--` into `-r--r--r--`).[179] Any of these changes only take effect when you commit.

This trick of editing a read-only Buffer to effect real, but indirect, changes is used elsewhere in Emacs.

[176] You can also commit your changes by toggling back to read-only with `C-x C-q`.

[177] Or just kill the Dired Buffer.

[178] Actually, in an abundance of caution, it will be *flagged* for deletion with a `D`, and you can `x` it after exiting Wdired.

[179] In another abundance of caution, this feature is off by default. You can enable it with `M-x customize-variable RET wdired-allow-to-change-permissions RET`.

Two-Panel Dired

Many file managers use a two-panel design: they divide a window into two (usually side-by-side), to make it easy to copy or move files from one directory to another. It's useful to run Dired this way as well. I recommend adding this to your Init File:

Init File

```
(setq dired-dwim-target t)  ; suggest other visible dired buffer
```

With this setting, you can just arrange for two Dired Buffers to be visible, and when you give any command that needs a target directory (like `C` (copy) or `R` (rename)), the default will be the directory of the other Dired. You don't *have* to accept this new default destination when prompted—you can override it in any individual case—and this setting only has an effect when you have two visible Dired Buffers.

DWIM, by the way, stands for "Do What I Mean", and is named for an error-correcting feature in an old Lisp system dating from 1966.

Searching and Replacing

Normally, if you want to search through all the files in a directory you use `M-x grep`, `M-x lgrep`, or `M-x rgrep` (see Meet the Greps). But you can also use the power of Dired marks to limit your search to a possibly idiosyncratic selection of the files in your Dired Buffer.

Just set your marks and run `A` (`dired-do-find-regexp`); any marked directories will be searched recursively, and if you don't have any marks, the file or directory at Point will be searched.

A Xref Buffer containing all the hits will pop up and you can navigate through them; see Figure 29.

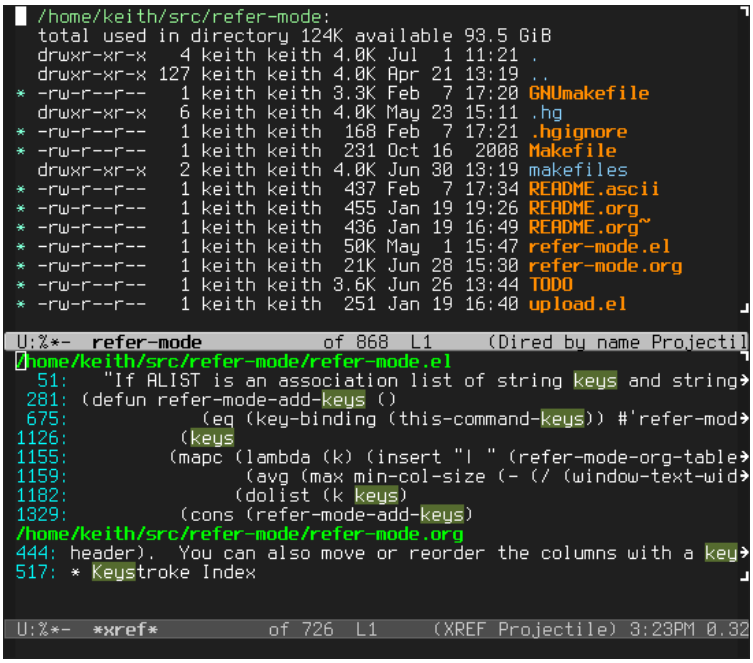


Figure 29: Search for "keys" within files in Dired

This search is really more of an Occur. You can also do an Incremental Search through the marked files. This is done with `M-s a C-s` (`dired-do-isearch`) or `M-s a C-M-s` (`dired-do-isearch-regexp`)[180]. These are basically entry points to `multi-isearch-files`, with the marked files eliminating the need to enter a bunch of filenames; see *Multi-Isearch* for details

You can also do a search and replace across your marked files with `Q` (`dired-do-find-regexp-and-replace`). This pulls up all the files with hits, one at a time, and in each runs a `M-%` (`query-replace`) for you. There are other ways (which I prefer) to do a search and replace across multiple files; see *Xref* and *Writable Grep*.

[180] A couple of handfuls, those are...

Diffing and Comparing

You can compare ("diff") the file at Point with another file with `=` (`dired-diff`). You'll be prompted for the second file; if the first file has a backup file, that will be the default (and vice versa). If the Region is active, the files at Point and Mark are the ones compared. A prefix argument will let you specify the options given to `diff(1)`.

You can also compare two *directories* in an interesting manner. Open two Dired Buffers on two different directories[181]; for the best demonstration, the directories should be similar but not identical, e.g.

[181] For your first try, make sure there are no Dired marks in either directory.

one might be an older version of the other. Then, in either Buffer, say `M-x dired-compare-directories`. Hit `RET` at the prompt:

```
Mark if (lisp expr or RET):
```

Now you'll (most likely) see that there are marked files in both directories: these are the files in each directory with unique names. So in directory *A*, if the file `foo` is marked, it means that there is no file named `foo` in directory *B*, and so on. Or, equivalently, the unmarked files in each directory are those that also exist (with the same names) in the other directory. Keep in mind that this comparison is done purely at the level of the file *names*; the contents do not enter into it.

Even just as a visual aid, this is useful for eyeballing the differences between the two directories. You can make use of the marks in either or both directories to do further comparisons (with `=`), deletions, or copying.

If you know a little Elisp, you can mark the files more precisely than by comparing their names; you can mark them based on their sizes, modification times, owner, permission, etc. Do:

```
C-h f dired-compare-directories
```

for more information.

Reverting and Sorting the Dired Buffer

The contents of a directory can change out from under Emacs, so you can refresh Dired's notion of the directory contents with `g`, which is bound to `revert-buffer` (as you might expect). This will reveal any new files, omit any files that were deleted outside of Emacs, and make the displayed file sizes, permissions, etc reflect the current state.

The `l` command (`dired-do-redisplay`) is a less broad version of this: it only redisplays the info for the marked files (or next *N* files, if given a numeric argument), or the files in a subdirectory, if issued on a subdir headline.

You can also sort the Dired Buffer by modification time (most recent files first), rather than the default alphabetical order, with `s` (`dired-sort-toggle-or-edit`). With a prefix arg, you'll be prompted to set the options for the `ls(1)` command that lists the files; the default options are `-al`[182]; the `-a` option causes files whose names begin with `.` to be included. If you don't want to see dot files, do `C-u s -l RET` (removing the `a` option) and the Buffer will be refreshed to exclude them. You can also throw in other `ls(1)` sorting options, like `-r`, `-S`, `-t`; see the `ls(1)` man page with `M-x manual-entry`. New options given in this manner are *sticky* in that they persist through subsequent `g`'s.

[182] The `-l` option is mandatory.

While the `-l` option is mandatory, you can hide everything but the filename with `(` (`dired-hide-details-mode`). That gives you a minimalist skinny Dired Buffer. Another `(` brings the details back.

You can customize the default `ls` options by setting `dired-listing-switches` in your Init File; I add `-h` (`--human-readable`) to print file sizes in a friendlier format (like 1K, 234M, 2G), for example. But check the variable's documentation for details; some `ls` options can break Dired.

Finally, the Dired Buffer supports a limited version of Undo, bound to the usual keys (e.g. `C-/`). This command can't magically undelete files, but it can revert changes to the Buffer itself. You can use it to recover changed marks, killed lines, or hidden subdirectories.

Omitting Uninteresting Files

Certain files can be considered uninteresting because you rarely want to manipulate them (except perhaps to delete them): you typically don't want to visit them, copy them, or anything else. These files include build artifacts; checkpoint, lock and backup files; and the `.` and `..` directories. The problem with these files in Dired is that they take up screen real estate (requiring more scrolling), and often have to be unmarked after you've marked, say, all directories, or all the files that match a regexp.

You can *omit* these files from your Dired listing with `C-x M-o` (`dired-omit-mode`), which toggles Omit Mode on and off. You can also mark all the files that Omit Mode would omit with `* O` (`dired-mark-omitted`).

If you'd like to have these files omitted from your Dired Buffers by default, as soon as you open up any Dired Buffer, add this to your Init File:

```
(add-hook 'dired-mode-hook 'dired-omit-mode)
```

You can un-omit them after that with `C-x M-o`.

The precise definition of which files are omittable is controlled by the variables `dired-omit-files` and `dired-omit-extensions`. See the Dired Extra manual for details and examples.

Running External Commands

If Point is on a file line in a Dired Buffer, then `!` (`dired-do-shell-command`) prompts for a command and runs it synchronously on that file; `&` (`dired-do-async-shell-command`) does the same thing asynchronously. So if Point is on a file `foo.sh`, and you want to know

how many lines or words are in that file, you just type `! wc`, and the result is displayed in the Echo Area; this is equivalent to `M-! wc foo.sh` (except you didn't have to type the filename), and the output is handled in the same way. You won't be surprised that `& wc` is equivalent to `M-& wc foo.sh`, and runs the `wc` command asynchronously.

But these commands are not *exact* equivalents. When you type `!` the prompt looks like this:

```
! on foo.sh [sh]:
```

The `sh` in the brackets is the suggested default command, so if you wanted to run this shell script rather than count its lines, you could just hit return. There may be more suggestions than just the one shown; you can use `M-n` (`next-history-element`) to scroll through them in the usual way; see *Future History*. Emacs has commands to suggest for 57 possible files types and you can of course add your own via the `dired-guess-shell-alist-user` variable.

`!` and `&` operate on multiple files in the standard Dired ways, via numeric arguments and marks. When you run a command on multiple files, a Window will open above the prompt listing all the files that will be affected—a nice reassurance.

What is the nature of the command*?*

Dired's `!` and `&` actually take an arbitrary shell command, so you can add options to the command (e.g. `! wc -l`) and it can even contain pipes and other shell-specific stuff, with the filename appended to the end of the command.

Emacs quotes all the filenames for you and the command is run once for each file. So if you mark the files `bar`, `baz`, and `foo`, and say `! wc`, Emacs will run `wc bar`, `wc baz`, and then `wc foo`, synchronously.

You can run just one `wc` command for all the files by saying `! wc *`; this wildcard is interpreted by Emacs and *NOT* given to the shell.[183] Instead of expanding to *all the files in the directory* as it would in the shell, Emacs will put the list of filenames being operated on at the location of the `*`, so `cp * some-directory` will work correctly[184]. The filenames being operated on are the marked files, or the file at Point, or the *N* files at Point if you uses a numeric argument of *N*, in the usual Dired interpretation. The order of the files in the expanded file list will match the order in which they occur in the Dired Buffer.

If you use `?` instead of `*`, Emacs will run a separate invocation of the command for each of the multiple files, just like in the no-`*` case.[185] What's the point of this, then? Well, you can repeat the `?` in

[183] But only if the `*` is surrounded by whitespace.

[184] The Dired `C` command actually performs this operation more easily, but let's pretend otherwise.

[185] Note that this is *not* the usual shell interpretation of its `?` wildcard!

the command and Emacs replaces each `?` with the same filename. The silly command `! mv ? /tmp/ && touch ?` will move each file to `/tmp/` and then replace it (in the original directory) with a new empty file of the same name.

Again, this special interpretation of `?` only applies if it's surrounded by whitespace. But there's one more special wildcard: `` `?` ``, which is interpreted exactly as `?` except for the surrounded-by-whitespace requirement. This means you can make backup files with a command like ! cp ? `?`.bak.[186]

[186] Though Dired's `% C` command is perhaps an easier or more natural way to do that.

You mentioned running commands in parallel?

The `&` command operates exactly like the `!` command, except that it runs asynchronously. So if you want to run your external PDF viewer on that Dired file, you probably want `&`. If you use `&` with *N* files, *without* using `*` in the command, it will run *N* separate commands in parallel.

Image-Dired

Dired can also be used as an image gallery, displaying thumbnails of image files. Just mark the files you're interested in[187] and say `C-t C-t` (`image-dired-dired-toggle-marked-thumbs`); see Figure 30. If no files are marked, `C-t C-t` will display the thumbnail for the file at Point.

[187] You don't have to carefully mark only image files, so the quickest way to see thumbnails for everything in the directory is to mark all the files with a simple `U t` (`dired-toggle-marks`).

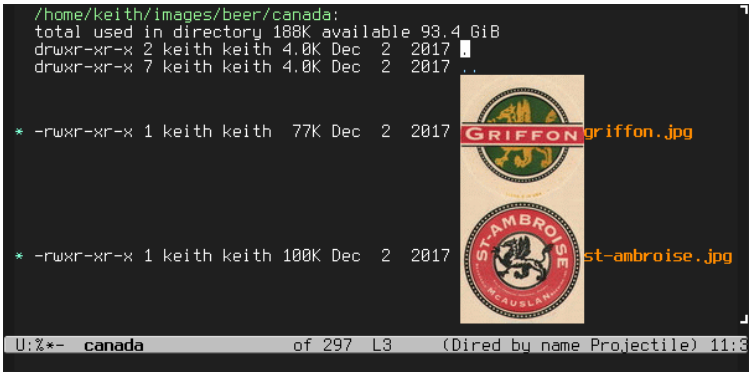


Figure 30: Inline thumbnails in `dired-mode`

You can of course see any image full-size by visiting its file, which will naturally come up in `image-mode`, but doing this will eventually clutter your Emacs with many image Buffers. If you just want to view some images more transiently, rather than `RET`, use `C-t i` (`image-dired-dired-display-image`), which will repeatedly use a single Buffer called `*image-dired-display-image*`; within this Buffer `f` will full-size the image and `s` will resize it back to the Window size. `C-t x`

(`image-dired-dired-display-external`) will display the image with an external image viewer, outside of Emacs.

A limitation of Dired is that it can only list files one per line, so you may have to do a lot of scrolling. Instead of inline thumbnails you can pop up an additional Window containing a new Buffer of thumbnails only. Again, mark the files of interest (or all of them) but this time invoke `C-t d` to display the thumbnails Buffer; see Figure 31.

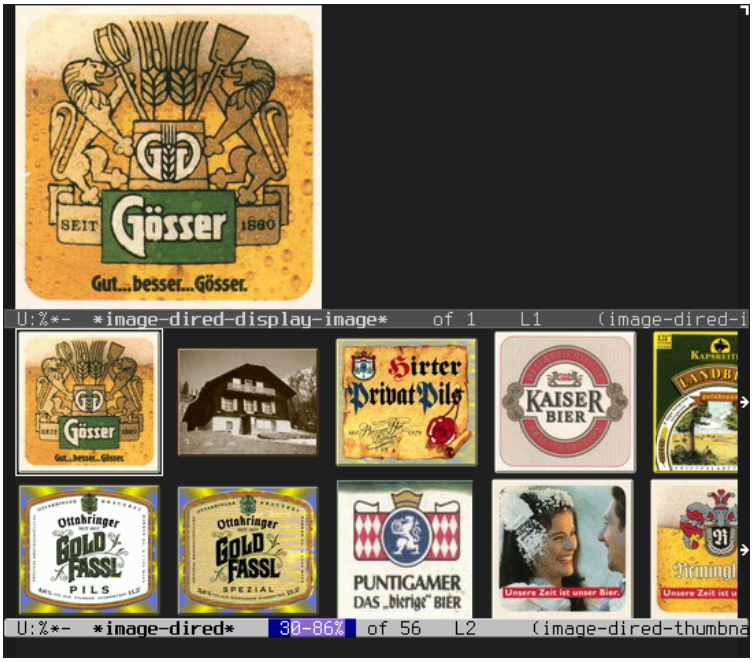


Figure 31: Image-Dired Thumbnails Buffer

In the thumbnails Buffer, you can move around with the usual motion commands; `RET` pops up the `*image-dired-display-image*` Buffer with a view of the image corresponding to the current thumbnail, and `SPC` and `DEL` page the display Buffer forward and backwards through the images. The Dired Buffer is linked to your motion through the thumbnails, so if you navigate to a thumbnail and then jump to the Dired Buffer, Point will be on the file corresponding to the thumbnail. You can also mark, unmark, and flag files from the thumbnail Buffer.

Tagging and Commenting Images

Images can be tagged and commented from the Dired Buffer. The image files themselves are not altered by this process; the tags and comments live in a metadata file in your `user-emacs-directory`. This allows you to set Dired marks on all the files with a given tag; after

you've done some tagging perhaps `C-t f cat` would mark all your cat images.

Table 21: `dired-mode` Image Tagging and Commenting Commands

Key	Action
`C-t t`	add a Tag to all the marked files
`C-t c`	add a Comment to all the marked files
`C-t e`	Edit both
`C-t r`	Remove the given tag from marked files
`C-t f`	mark all Files with given tag

Remote Directories

In addition to opening a directory on your local disk, Dired can also open a directory on a remote computer, perhaps your office desktop at work. I almost didn't think to mention this, because it's in no way a special feature of Dired, but just falls out of Emacs's ability to manipulate remote files via Tramp. So when you run Dired, if you name a directory using Tramp's remote file syntax, then naturally the Dired Buffer is remote, and all the Dired operations—file copies, renames, deletions, visits, even shell commands via `!` (`dired-do-shell-command`)—run on the remote host. Just as naturally, in a local Dired, you can copy or rename a file *to* a remote host: when prompted for the target filename, just use Tramp syntax. This even works with the mass name-changing functions, and works seamlessly in two-panel DWIM mode. See *Tramp* for details.

More Dired Entry Points

Normally `C-x d` (`dired`) is invoked with a directory name, but you can also invoke it with a glob pattern: `C-x d *.el` will bring up a Dired Buffer with all, and only, the Elisp files in the default directory.

And there are more ways to get a Dired Buffer than just `C-x d`. `C-x C-j` (`dired-jump`) or `C-x 4 C-j` (`dired-jump-other-window`) from within a file Buffer will open Dired on that file's directory. `M-x find-name-dired` will prompt you for a directory, and then for a filename, possibly containing Unix wild cards (*glob* characters); it will generate a Dired Buffer containing all the matching files under the named directory, recursively. So you might want to run Dired on all your Elisp source files under your source code directory with:

```
M-x find-name-dired RET ~/src RET *.el
```

This command is a convenient interface to the Unix `find(1)` command; `find-dired` is a more full-featured version that let's you specify any `find` options you like. `find-grep-dired` is much the same,

but limits the files to those that *contain* a Regular Expression as for `grep(1)`.

You can use `find-name-dired` to find files from *anywhere* on your system if you give `/` (the top-level *root* directory) as the starting directory, but if you have a large disk with many thousands of files, this can be slow. `M-x locate` is the Emacs interface to the Unix `locate(1)` command that uses a database of filenames and so runs much faster.[188] `M-x locate-with-filter` has an additional prompt for a Regular Expression that's used to filter (limit) the hits.

[188] Note that `locate(1)` only works if your system is regularly updating its database; this is outside of Emacs's purview.

You shouldn't try to quote any of the arguments to any of the `find-` and `locate-` commands—Emacs takes care of that for you—with the exception of `find-dired` (because that one requires you to enter a raw `find` command).

Many Major Modes provide custom entry points to Dired. For example, `doc-view-mode` can pop up a Dired on its cache directory, EMMS will open Dired on the music files in your playlist, and Projectile will open Dired on your current project.

Third-Party Directory Tools

There are some 65 packages in MELPA that provide various enhancements to Dired, like fancy multi-panel layouts, sidebars, displaying file-type icons next to the files, cleaning up duplicate files, and more. One of the most useful is Pierre Neidhardt's `disk-usage` package, which finds the files and directories that are taking up the most space; see Figure 32.

Figure 32: `M-x disk-usage` and Dired

References

- See "Dired" in the *Emacs* manual.
- Kremer, Sebastian and Free Software Foundation. 2022. *Dired Extra.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET dired-x RET`.

Searching . . .

Searching is one of the most important Emacs skills. It's pervasive: since it works in (and across) your Buffers, it works, identically, not only within a file you're editing, but within the user interfaces (UIs) of Emacs and its many subsystems—the Help system, Dired the file manager, the Emacs documentation, your shells and terminals, your mail, your calendar and diary, your web browser, your music player—everything. Imagine if you could explore and find your way around the UI—the menus and toolbar—of a GUI application like your web browser the same way you can search the text of one of its web pages. And to top it off, Emacs's search facility is far more powerful than that of any GUI application.

Searching can be divided into two major flavors: *incremental search style* and *occurrences style*. Incremental Search, which you may think of as "find as you type" — a now common user interface feature invented in Emacs in the 1970s — is probably the most important. It takes you hit-by-hit through all the match locations in that Buffer (with highlighting).

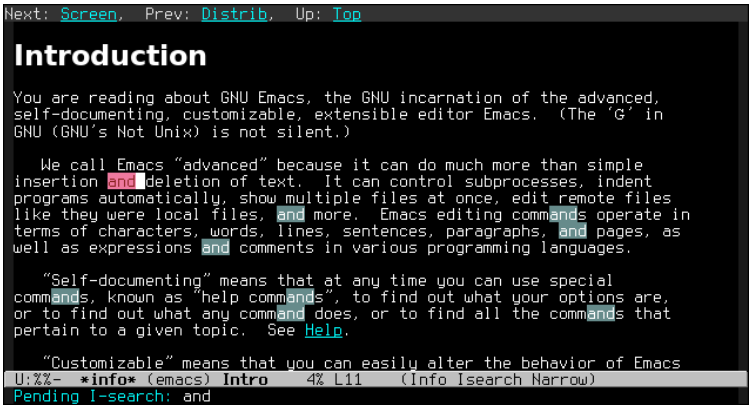


Figure 33: Incremental Search in Action

Occurrences-style search works more like a web search engine: you type in your query and Emacs pops up a *new* Buffer full of hits, from any of which you can jump to the actual occurrence. There are many forms of this, exemplified by `M-x occur`, which presents the

matches from your current Buffer.

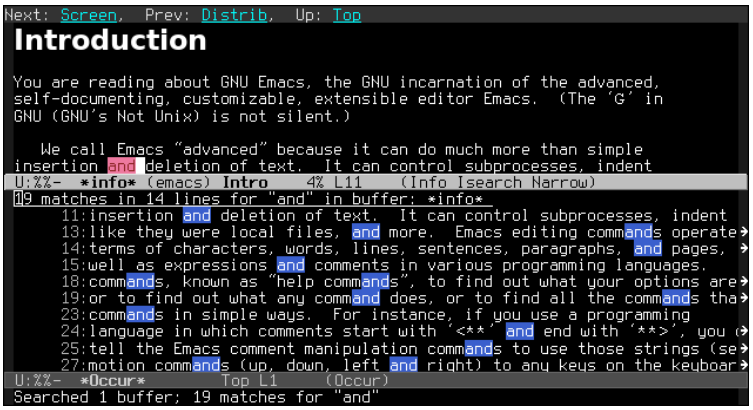


Figure 34: ... Transformed to Occur with a Keystroke

Occur also resembles the output of the Unix `grep(1)` command (especially with the `--color` option turned on): the Buffer of hits is like the lines of `grep` output, except you typically can't click on a hit in the terminal and be taken to that line of the matching file. That is, unless you run `grep` under Emacs; see *Meet the Greps*.

Incremental Search

Incremental Search (*Isearch*) is a commonly used way to move around when you're editing text: it's so fast and easy, I'll even use it just to move to a spot in the same line. As befits one of the most heavily used features of Emacs, Isearch is very powerful and thus very complex. But if you have an idea of what's possible, you can start out easy and add fancy features as you gain experience. I would say I use most of these features, but not all, and a few were surprises when I delved deep into the manual in order to write this chapter.

The command `C-s` (`isearch-forward`) starts a search and prompts in the Minibuffer for a search string:

```
I-search:
```

Suppose you're looking for occurrences of the word "and": just start typing it. As soon as you type the letter "a", all the "a"'s visible in the current window will be highlighted a light blue, except the very next "a" after Point, which will be violet-red[189]; in fact, Point has been moved to this location. Now the prompt looks like:

```
Pending I-search: a
```

Add "n" to your search, and all the highlights will be updated: now only occurrences of "an" will be highlighted, and if necessary, Point will be moved ahead to the first match. Add your final "d" and now only "and"'s are highlighted.

[189] These are the colors I see in my reverse-video color scheme; they may be different for you.

```
Pending I-search: and
```

If the first "and" after Point isn't the one you want, just type `C-s` again, and Point will advance to the next "and"; you can keep `C-s`'ing through the hits. If the next hit is off-screen, the window will scroll. When you've reached the "and" you wanted, just hit `RET` to terminate the search; Point is now at the end of the chosen "and".

The whole point of the *incremental* part of Isearch is that you often don't need to type the entire string that you're searching for: once Point reaches the right spot, just hit `RET` and you're done. You can also start `C-s`'ing ahead at any point. If you're searching for the word "pneumonoultramicroscopicsilicovolcanoconiosis", there's a good chance you'll have found it after "pn"; at any rate, you probably won't have to type in all 45 characters.

Failing Searches and Making Corrections

If the string you're searching for isn't present in the Buffer, Emacs will beep and you'll see in the Minibuffer something like:

```
Failing char-fold I-search: zq
```

It's likely that a prefix of your search string (here, "z") is in the Buffer, but the complete string ("zq") is not. Perhaps you *meant* to search for "zap": just use `DEL` (`isearch-delete-char`) to delete the "q" and make your correction.

If you're typing quickly, you might get in a whole bunch of non-matching characters at the prompt; that's okay: you can delete them all one at a time with `DEL`, but hitting `C-g` will delete all the non-matching characters in one go.

When moving from hit to hit with additional `C-s`'s, you may overshoot the hit you want. `DEL` will "correct" this mistake too, taking you back to the previous hit.

If you hit the end of the Buffer during a search, Emacs will likewise beep and indicate search failure; but if you hit another `C-s`, your search will wrap around to the *beginning* of the Buffer and continue searching from there. The word "Wrapped" will appear in the prompt to indicate this; if you go all the way around, returning to your starting point, and keep going, the prompt will change to "Overwrapped" to make it clear that you've seen all these hits already, and there are no more new ones.

Editing Your Search

Suppose you've started Isearching for the word "stolidity" and only then noticed that you really meant "solidity". You don't have to do

eight DEL's and then type a "t" and then retype "olidity": you can put your Isearch into edit mode with M-e (equivalently, M-s e); now you can use all the usual editing features of Emacs, as you usually can in the Minibuffer, to go back and just delete that "t". When your edit is done, restart your Isearch with any of RET, C-s, or C-r[190] and continue from there.

[190] To search in the reverse direction.

Aborting Your Search

Because C-g, usually keyboard-quit, in Isearch has the handy use of zapping non-matching search characters, you need to use *two* C-g's to abort your search, leaving Point where you started.

Quick Search Exit

For the sake of editing speed, any other non-Isearch Emacs command will also end the search successfully, and be immediately executed. You could exit with M-f (forward-word), for example: C-s zap M-f is equivalent to C-s zap RET M-f: both will leave Point at the end of the word following "zap".

Scrolling

Scrolling commands normally terminate the search and then scroll, as per above, but I like to be able to scroll the window in mid-search, to see what's coming up (or what's behind me). This Init File snippet allows most scrolling commands (like C-v (scroll-up-command), M-v (scroll-down-command), and C-l (recenter-top-bottom)) to work this way.

```
(setq isearch-allow-scroll t)           ; scroll while searching
```

The Region is Set for Free

When you end a search successfully, you'll notice this message in the Minibuffer:

```
Mark saved where search started
```

This means that the Region (though inactive) is now around the text, from where you started the search to where you are now, and you can do whatever you like to the region (kill, copy, or modify it). You can jump back to where you came from with C-x C-x (exchange-point-and-mark) or C-u C-SPC (set-mark-command).

Changing Directions

If you know the string you're looking for precedes Point, you can instead start your search with `C-r` (`isearch-backward`). You can reverse direction at any time with `C-r`, and change back to going forwards again with a `C-s`, as needed. The commands `M-s M-<` and `M-s M->`, which jump to the first match or last match respectively, *without* terminating your search, can be useful for fine-tuning your position before or after changing directions.

Restarting Your Last Search

Immediately after starting a search with `C-s`, if you type another `C-s`, it will search for the last search string you used (the same is true if you start with `C-r`—an immediate `C-r` reinvokes your previous search). Think of the sequence `C-s C-s` as "redo my last search" (same for `C-r C-r`).

Isearch maintains a history of your last 16 search strings in the usual ring structure. Just use `M-p` and `M-n` as usual to navigate through your searches; when you've pulled up the one you want, you can edit it before starting the search with another `C-s` or `C-r`. There are separate histories for simple string search and for regular expression search.

Searching for Funny Characters

If you need to search for a non-printing character (which would normally terminate your search), you can do so by *quoting* it with `C-q`.[191] So you can search for a `C-g` (ASCII 007) with `C-s C-q C-g`. To include an explicit newline in your search string, just use a simple `C-j` (the ASCII linefeed or newline character), which you don't have to quote.

[191] Which is just what you normally do to insert a non-printing character in any Buffer; see *Quoted Insert*.

Case Sensitivity and Whitespace

Searches are case-insensitive[192] by default, so "and" will also find "And" and "AND", etc. But if you include an uppercase letter anywhere in your search string, then the search is performed case-*sensitively*.

[192] Emacs calls this *case-folding*.

Whitespace is treated abstractly: by default, a single space will match a sequence of any whitespace characters (space, tab, formfeed, and newline in most Major Modes). This is called *lax space matching*.

Varieties of Isearch

The cases just described are only defaults; you can toggle any of them on or off in mid-search with the following special `isearch-mode` commands, any of which only affects the current search and doesn't "stick" for future searches (but you can set your preference of default for each; `M-x customize-group RET isearch`).

`M-s c` *Case Folding* Toggle case folding on and off; this command is also on `M-c`. *On* by default.

`M-s SPC` *Lax Space Matching* Toggle lax space matching on and off; when off, one space character matches only a single space and not a run of spaces or a combination of other whitespace characters. *On* by default.

`M-s '` *Diacritic Folding* Toggle diacritic folding[193] on and off. (Mnemonic: the apostrophe `'` is like an acute accent.) When on, an unadorned letter will match that same letter with any diacritical mark. So, searching for "cafe" will also find "café". *Off* by default. I recommend turning this on by default with this Init File snippet:

[193] Emacs calls this *character folding*.

Init File

```
(setq search-default-mode 'char-fold-to-regexp) ; cafe = café
```

`M-s w` *Word Search* Toggle word search on and off. When on, the search string will only match complete words (so "an" will match neither "any" nor "man" nor "pants"). Your search string can be a sequence of space-separated words and those complete words will match with any amount or combination of whitespace and punctuation between them. *Off* by default.

`M-s w` also has a global binding to `isearch-forward-word`, which initiates an incremental word search.

`M-s _` *Symbol Search* Toggle Symbol Search on and off. Symbol search is exactly like word search, except it deals with *symbols* rather than words, according to the current Major Mode. In programming language modes especially, Emacs symbols represent variable and function names, which can contain punctuation characters which aren't typically allowed in Emacs *words*. An example is that most languages allow _ in symbols, but _ is usually not considered part of a word.[194] (Hence the `M-s _` mnemonic.) *Off* by default.

[194] "Typically" and "usually" because of course Emacs allows you to declare that _ is part of a word in any given buffer or Major Mode.

`M-s i` *Search Invisible Text*

Emacs has the ability to make text invisible; `M-s i` toggles whether or not an incremental search will match text that's currently invisible. For example, Outline Mode and Org Mode let you hide

("fold") the text within nested subheadings, so you can focus on the outer text; Selective Display hides indented text (say in programming language modes) for the same reason. *Off* by default.

`M-s r` *Regular Expression Search*

I've saved the best (perhaps) for last. `M-s r` (also on `M-r`) toggles between simple string search, which we've been discussing, and *regexp search*, which uses the powerful pattern matching language of *regular expressions*. This is so important and so heavily used that you can start out in a regexp search via the global bindings `C-M-s` (`isearch-forward-regexp`) and `C-M-r` (`isearch-backward-regexp`). *Off* by default.

Other than searching for complex patterns rather than simple strings, incremental regexp search is almost identical to Isearch, supporting all the features described in this section. The main exceptions are that lax spacing is *not* on by default (you can toggle it on with `M-s SPC`) and that diacritic folding is not available.

Why does Emacs have both simple string search and regular expression search? In editors that only have regexp search, you have to do a lot of quoting of the regexp metacharacters (like a simple `.` or `$`); on the other hand, if you only have string search you can't do powerful searching. So we have to have both, equally easy to use.

Nonincremental Search

Emacs's incremental search is now the standard way to search; almost all editors and many other applications (e.g. web browsers, shells) have adopted the idea[195]. But I suppose you may occasionally want to do a non-incremental search, and you can do that with `C-s RET` or `C-r RET` — in other words, begin your search by hitting return and the prompt will change from `I-search` to `Search`, and now you have to type your complete search string without seeing any intermediate matches. When you've typed it in, hit `RET` to do the search and you'll be taken to the first match. Period. Your search is over. To find the next hit, you have to do `C-s RET RET`, which will reuse the previous search string.

So disappointing. This is the way all searches used to work before the invention of incremental search.

Why would you want to do this? I guess you can think of it as equivalent to `C-s` followed by an immediate `M-e` to edit the search string. Perhaps nonincremental search is for people who haven't yet learned how to yank.

[195] Though not always with highlighting as sophisticated as Emacs's.

Yanking Into the Search

Table 22: Isearch Yank Commands

Key	Action
`C-w`	Yank next word from buffer
`C-M-w`	Yank next symbol from buffer
`M-s C-e`	Yank remainder of line from buffer
`C-M-z`	Yank string up to given character
`C-M-y`	Yank character at Point

Frequently you want to search for some text that is right in front of you in the current Buffer, and the properly lazy Emacser never wants to type in text unnecessarily. Instead, you can yank text at Point right into your Isearch. You can do this right after starting a search, or after you've typed part of your search string. You can also yank in text from the Kill Ring in the usual manner with `C-y` and `M-y`. See Table 22.

Transitioning to Other Search Types

Key	Action
`M-r`	Switch to regexp search
`M-s o`	Switch to `occur`
`M-%`	Switch to `query-replace`
`M-s h r`	Terminate search, leave highlights

You'll find that Isearch is your goto-search—the one you automatically reach for—but `isearch-mode` provides shortcuts to transition to other searches, so that you don't have to abort your Isearch and start over.

You can switch from simple string search to regular expression search with `M-r`— perhaps your simple search isn't finding enough matches; you may need to use `M-e` to convert your search string to a more complex regexp.

I use the `M-s o` transition a lot: without terminating your Isearch, it pops up a Buffer of hits, search-engine style, as if you had done `M-x occur`; see Figure 34.

You might decide in the middle of your search that you want to convert all the matches to something else; `M-%` will switch to a `query-replace`, using your search string as the text to replace. If you're doing a regexp search when you hit `M-%`, it will switch to `query-replace-regexp` instead.

Finally, while it's not really a transition to a different kind of *search*, `M-s h r` will terminate your search, leaving all the hits in the Buffer highlighted in a color of your choice; see *Highlighting*.

Help

With `isearch-mode` having 80-odd key bindings, you might have trouble remembering them all, so just try to remember `C-h C-h`, which will pop up a special Isearch help Buffer. For another perspectives on all this, see "Incremental Search" in the *Emacs* manual.

Occurrences

Incremental Search gives you an overview of the matches for your search string (via colorization), but if your Buffer is large and your matches are spread out, you won't be able to see very many of them without stepping through them all

`M-x occur` (also on the global binding `M-s o`) gives you a more compact overview of the matches in a separate Buffer named `*Occur*`. It might look like this (partial view of the `*Occur*` Buffer):

```
29 matches for "^#\+name:" in buffer: use-emacs.org
   125:#+NAME: info-nodes
   209:#+name: age-in-years
   4277:#+name: image-mode-scaling-commands
   4290:#+name: image-mode-scroll-keys
   4404:#+name: basic-dired
   6218:#+NAME: shell-commands
   6695:#+NAME: face-count
```

This is rather like a results page from a web search engine. It tells you how many total matches there were, and each hit shows the complete line it occurred on, preceded by its line number; you remain in the Buffer from which you issued the `occur` command.

This gives you a nice overview, and you can jump directly from match to match with `C-x ‘` (`next-error`) or its more mnemonic binding, `M-g M-n` (Go to Next hit).[196] Each `M-g M-n` moves Point to the next matching line in the original Buffer—the Point in the `*Occur*` Buffer follows along—so you can step through all the hits.

(Why "`next-error`"? These search hits don't seem like errors! The reason is that this is just one of many use cases for a command that originated to step through the error messages from a compiler for a programming language; see *Compiling Code*.)

Instead of staying in the original Buffer and stepping though *all* the hits, you can switch to the `*Occur*` Buffer and navigate to the lines of interest, where you can hit `RET` to jump to that line in the original Buffer or `C-o` to stay in the `*Occur*` Buffer but scroll the original Buffer to show that line in context.

Of course you might use an Isearch to navigate in the `*Occur*` Buffer, and in a big `*Occur*` Buffer, I actually sometimes use… `M-x`

[196] This is also bound to the less felicitous `M-g n`.

occur! Yes, an occur within an *Occur* Buffer is a way to *narrow* the occurrences to a more precise list. This all just works because, well, buffers are buffers and text is text, even though *Occur* is the user interface of the M-x occur application!

Writable Occur, or occur-edit-mode

One of the more amazing features of occur is occur-edit-mode, bound to e in the *Occur* Buffer. This one of Emacs's Indirect Editing features. Normally, the *Occur* Buffer is read-only, but typing e allows you to edit the Buffer. The amazing part is that when you're done editing, give the command C-c C-c[197] (occur-cease-edit) and all your edits are applied to the matching lines in the *original* Buffer! You can use any techniques to make these changes: not just manual slogging, but things like M-% (query-replace) or a Keyboard Macro.

[197] The usual Emacs "finish up" or "I'm done" key binding.

Multi-Buffer Searching

With a long-running Emacs server, I typically have fifty or more buffers going at any given time — files, shells, emails, web pages, directories, etc. How on earth do you find anything?

The best way to search *all* of your Emacs is to say C-u M-x multi-occur-in-matching-buffers. You'll be prompted for a regular expression to target the buffers you want to search; just enter ".":

```
List lines in buffers whose names match regexp: .
```

Then you'll be prompted for your search string (actually another regexp); we should get lots of hits for "the":

```
Collect strings matching regexp: the
```

Normally this command only searches buffers that are visiting files, and the first regexp is matched against the buffer's visited filename, but with the prefix argument (C-u), it searches *all* buffers, so that will include Dired buffers, music player buffers, Help and Apropos buffers, shell and terminal buffers: everything.

I just did such a search for the word "the": in about one second, a new *Occur* Buffer popped up showing "3518 matches in 2609 lines total across 108 buffers". The Buffer looks mostly like a normal *Occur*, but the matches are grouped by Buffer; here's an incomplete, edited example (all the occurrences of "the" will be colorized):

```
3518 matches in 2609 lines total for "the":
24 matches in 17 lines in buffer: sittin-on-the-dock-of-the-bay
      1:{title:Sittin' On the Dock of the Bay}
      6:[G]Sittin' in the mornin' [B]sun
      7:I'll be [C]sittin' when the ev - [B]en - [Bb]in' [A]comes
6 matches in buffer: captain-beefheart
      4:*  The GREAT essential records
      7:- Doc at the Radar Station (1980)
     10:* The Good
     13:- The Spotlight Kid (1972)
241 matches in 185 lines in buffer: texmf.cnf
      9:% (Below, we use YYYY in place of the specific year.)
```

All the usual Occur commands work in this Buffer, including `e` (`occur-edit-mode`).

Instead of `multi-occur-in-matching-buffers`, you can instead use plain old `M-x multi-occur`, which prompts you, one at a time, for the set of Buffers to search; you can use completion on the Buffer names.

You can also do a multi-incremental-search. Personally, I think this is more awkward than Multi-Occur, but your mileage may vary. It's just like a regular Isearch except, when you hit the end of a Buffer, a `C-s`, instead of wrapping around to the beginning of that Buffer, advances to the next Buffer that contains a match. `M-s M-<` and `M-s M->` are especially useful here to skip over entire buffers and keep searching.

There are several entry points. In Table 23, "listed" means you'll be prompted to list the targets (buffers or files), and "regexp" means you'll enter a regular expression to match the targets.

Table 23: Multi-Isearch Entry Points

Targets	String Search	Regexp Search
Buffers, listed	`M-x multi-isearch-buffers`	`M-x multi-isearch-buffers-regexp`
Buffers, regexp	`C-u M-x multi-isearch-buffers`	`C-u M-x multi-isearch-buffers-regexp`
Files, listed	`M-x multi-isearch-files`	`M-x multi-isearch-files-regexp`
Files, regexp	`C-u M-x multi-isearch-files`	`C-u M-x multi-isearch-files-regexp`

. . . and Replacing

One of the main reasons to search is in order to move to a new location. The other is to replace text.

The most important find-and-replace command is `M-%` (`query-replace`). It prompts for a string to replace (we'll use "vim"):

```
Query replace (default foo → bar): vim
```

and then the replacement text (we'll use the obvious):

```
Query replace vim with: emacs
```

Emacs then finds the first match for "vim" after Point, highlighting it (and all the upcoming matches) in the manner of Isearch, and then asks what to do with this match:

```
Query replacing vim with emacs: (? for help)
```

Basically you type `y` to do this replacement or `n` *not* to do so, and Emacs then jumps to the next match, and we repeat the process until we finish with the final match in the Buffer.

To do the entire Buffer, first jump to the beginning with `M-<` (`beginning-of-buffer`). With a negative prefix argument[198], the replacements can be done backwards from Point.

[198] E.g, `C-u - M-%`.

With a simple prefix arg—just `C-u`—the search string is matched as a whole-word as if for `M-s w` (`isearch-forward-word`).

There are many more valid answers to the replacement question than just yes and no; see Table 24.[199] Most important is `!` which replaces all the remaining matches in one go, no questions asked. It's typical that you *intend* to do all the replacements, but want to see the first few in context before committing yourself with `!`. Sometimes you don't have time to see the effect of the replacement because Emacs has jumped to the next match and scrolled the replacement off-screen; in this case, just hit `^` to jump back to where you were and take a look (more `^`'s will step back through more replacements). When you're happy, just hit `SPC` to continue replacing where you left off.

[199] The non-mnemonic `SPC`, `DEL`, and `RET` keybindings are what we old-timers are used to.

If you're *not* happy with the replacement you've just done (maybe you hit `y` on autopilot when you meant `n`), you can undo it with `u`;

Key	Action
SPC, y	replace this match and proceed
DEL, n	skip this match and proceed
!	replace all remaining matches without asking
^	jump back to previous match
,	replace this match but don't proceed yet (stay here)
u	undo previous replacement
U	undo all replacements
e, E	edit the replacement string
RET, q	Quit without replacing this one
.	replace this match, then quit
C-r	enter Recursive Edit
C-w	delete match and enter Recursive Edit

Table 24: Query Replace Actions

Point will jump back to that spot, undo the change, and you can think again; any action is possible here. You can even undo *all* the replacements you've done so far with U, after which you might want to edit your replacement text with E and then start over, all without quitting the query-replace.

Sometimes you *do* want to quit early; q or . will do the job[200]: perhaps you only wanted to do your query-replace in the current paragraph.

[200] As for Isearch, any other Emacs command will also end the query-replace, without replacing, and be immediately executed.

Actually, in that case you'd be wiser to set the active region around the text you want to replace within; if the Region is active, query-replace will only operate on matches within it, and so you can safely use the convenient ! without affecting anything outside the Region.

Sometimes you're stepping through replacements and find a spot where you want to use a completely different replacement string—but just this once. You could quit with q, manually do the replacement, and then reinvoke M-% from that location to continue—Emacs helpfully offers your previous search string and replacement as the default. The disadvantage of this is that you can no longer use ^ to go back to locations from the preceding M-%, since it was terminated; nor will U undo any of those changes. Not a big deal, but there's a fancier way: instead of quitting, use C-r to enter a Recursive Edit, make your anomalous change, and use the usual C-M-c (exit-recursive-edit) to exit the Recursive Edit and continue your query-replace session. C-w is a handy shortcut.

Once you've done a few Query Replaces, you'll notice that it's *case-smart*. Firstly, if your search string is entered in all lowercase letters, it is matched in a case-insensitive mode (just as with Isearch). In our "vim" → "emacs" example, if one of the vims in the Buffer is capitalized ("Vim") then you'll see this prompt:

```
Query replacing vim with Emacs: (? for help)
```

Note that instead of replacing with "emacs", it's going to use "Emacs", to match the case of the "Vim". Likewise, if there's a "VIM" the replacement will be "EMACS".

If your search string contains any uppercase letters, the searches will be done case-*sensitively*, and likewise your replacement text will be used without modification. So `M-%` "Vim" → "emacs" will only match "Vim" and will replace it with your all-lowercase "emacs". If your search string is all lowercase but your replacement string contains any uppercase letters, the search is case-insensitive but the replacement will be done exactly as given every time. In Table 25, we summarize the three cases: the String column is the text in your Buffer, and the Replacement column shows the result of responding with `y`; an empty Replacement means that the particular String wasn't considered a match.

Table 25: Case-smart `M-%` examples

Search	Replace	String	Replacement
`vim`	`emacs`	`vim`	`emacs`
		`Vim`	`Emacs`
		`VIM`	`EMACS`
`Vim`	`emacs`	`vim`	
		`Vim`	`emacs`
		`VIM`	
`vim`	`Emacs`	`vim`	`Emacs`
		`Vim`	`Emacs`
		`VIM`	`Emacs`

You'll notice in the initial prompt that there's a default search and replacement pair which is your previous invocation (in the example above, it's to replace "foo" with "bar"). Just hit `RET` to accept it and begin the process. Alternately, you can use the familiar `M-p` and `M-n` to cycle through your history of Query Replace invocations. At any point you can edit either the search string part or the replacement part.

Some other Emacs commands—such as Dired's `Q` command, `M-x xref-query-replace-in-results`, or `M-x tags-query-replace`— will invoke a Query Replace for you on multiple buffers. In these multi-Buffer replacements, `!` will do unconditional replacement *just* in the current Buffer; use `Y` (note the caps) to replace all of the remaining matches in *all* the remaining buffers, or `N` to skip to the next Buffer without replacing the remaining matches in the current Buffer.

Query Replace with a Regular Expression

If Query Replace isn't powerful enough for you, you can try `C-M-%` (`query-replace-regexp`), where instead of a simple search string, you

use a Regular Expression. It works much like `M-%`, but your regexp search pattern can match much more flexibly. For example, we might want to go beyond just replacing "vim" with "emacs" via this regexp:

```
\<\(\(neo\)?vim\|vi\|ed\|\(vs\)?code\|sublime\( *text\)?\|atom\)\>
```

which allows us to replace a whole collection of apostate editors with Emacs.

In addition to supporting a fancier search string, `query-replace-regexp` also supports special features in the replacement string. In order to start using these very handy features, as long as you stick to letters, digits, and whitespace—all of which, as regexps, work as you'd expect—you can start using `query-replace-regexp` without waiting to become an expert in Regular Expressions. But if you want to use any other characters in your regexp, even just the humble period (`.`), you'll have to learn how to *escape* them first.

If you include `\#` in the replacement text, that pair of characters is replaced by the number of replacements that have already been performed, so if our Buffer contains:

```
foo foo foo foo foo foo
```

and we execute `C-M-% foo RET foo\#` at the beginning of the Buffer, the resulting Buffer is:[201]

```
foo0 foo1 foo2 foo3 foo4 foo5
```

[201] It may seem odd to you that the numbering doesn't start at one, but programmers tend to start counting from zero.

The sequence `\?` in the replacement text will result in a prompt for a string, so that you can replace each `\?` with whatever you like. Consider this command: `C-M-x foo RET foo\?`. First you'll need to decide whether or not to perform this replacement, as usual, by responding `y` or `n`; if you choose to do the replacement, you'll now get an additional prompt:

```
Edit replacement string: foo
```

Now you can edit the replacement to be `foobar`, `barfoo`, `antiparticle`, the empty string (to delete the match), or anything else. For the next replacement, you'll be prompted anew, and can respond with a completely different string (or use `M-p`'s to pull up replacements from the history). You can use more than one `\?` if you like.

Almost the most powerful feature of `query-replace-regexp`, though, is that you can refer to the text matched by the regexp, and the text matched by any *capturing parentheses* within it, in the replacement text via *back references*. In the replacement string, `\&` stands for the entire match. Even if you aren't using any of the pattern-matching features of regexps, this can save you some typing. `C-M-% emacs RET the amazing \& RET` replaces each "emacs" with "the

amazing emacs"; since "emacs" is all lowercase, this replacement is case-smart.

When your regexp matches more than just a literal string, then a back reference is the only way to include the match in the replacement. Suppose you want to put quotes around all the numbers in your Buffer. The regexp `[0-9]+` matches any number, so you can do this with `C-M-% [0-9]+ RET "\&" RET`.[202]

[202] You could also do this task with a Keyboard Macro, but a Query Replace will be simpler, and will also always run faster.

Capturing parentheses let you refer to just a part of the match. Suppose you have a number of strings of the form "foo56", "foo765", "foo3" and the like, and you need to change all the "foo"'s to "bar"'s, yielding "bar56", "bar765", and "bar3", but *not* change any standalone "foo"'s that don't have an attached number. You can do it this way: `C-M-% foo\([0-9]+\) RET bar\1 RET`. The `\1` refers to the *first* parenthesized subexpression; if you have two sets of parens, you can use `\2` as well. This means you can change all numbers like "10K", "542M", and "2.3G" to "10 K", "542 M", and "2.3 G" with `C-M-% \([0-9.]+\)\([KMGTPEZY]\) RET \1 \2 RET`.

You could also change all the `foo[0-9]+` matches to just plain "foo" with the command `C-M-% foo[0-9]+ RET foo RET` or in fact delete *all* trailing numbers from *any* words with `C-M-% \([a-z]+\)[0-9]+ RET \1 RET`.

Because of back references and the other handy backslash-sequences, if you actually want to include a backslash in your replacement, you'll need to double it. That is, `\\` is replaced with a single `\`.

Regexp	Replacement	Example Match	Result
`emacs`	`the amazing \&`	Emacs	The Amazing Emacs
`[0-9]+`	`"\&"`	3645	"3645"
`foo\([0-9]+\)`	`bar\1`	foo765	bar765
`\([0-9.]+\)\([KMGTPEZY]\)`	`\1 \2`	10K	10 K
`foo[0-9]+`	`foo`	foo765	foo
`\([a-z]+\)[0-9]+`	`\1`	xyz123	xyz

Table 26: `query-replace-regexp` Examples

Elisp Replacement Strings

Above, I said back references were *almost* the most powerful `query-replace-regexp` feature. Undoubtedly the most powerful feature is the ability to apply an arbitrary Elisp expression to the matched string and use the result as the replacement: that is, to *compute* a replacement from each match. `\,` (backslash-comma) followed by an Elisp expression can be used anywhere in the replacement, including more than once. Within the expression, you can use all the backslash sequences we've discussed above.

To use the feature you need to be pretty well-informed about both Regular Expressions and Emacs Lisp, so I won't go into this any further after giving a trivial example. Note that the Elisp expression:

```
(1+ x)
```

where `x` is some number, returns the successor of that number, so `(1+ 6)` evaluates to `7`. Remember that `\#` can be used to number your replacements, but that the numbering starts at zero. We can arrange for the numbering to start at one with the replacement string:

```
foo\,(1+ \#)
```

so our example above would yield:

```
foo1 foo2 foo3 foo4 foo5 foo6
```

See *Regular Expressions* and *Programming the Lisp Machine* for more information.

Other Entry Points

There are two other string replacement commands that you can use: `M-x replace-string` and `M-x replace-regexp`. They are non-interactive versions of `M-%` and `C-M-%` respectively. They work exactly the same, including their interpretation of prefix arguments and of replacement strings, they just run in "batch mode": they do all the replacements without any questions. I literally *never* use these commands, because the interactive versions are just as fast as soon as you decide it's okay to hit `!`, and I always like to see the first one or two replacements before I commit. That said, a single Undo will undo all the changes in one go (also true of the interactive versions).

Meet the Greps

Figure 35: `M-x grep`

Emacs also has its own interfaces to `grep(1)` for searching across files outside of Emacs, whether (1) a set of specific files, (2) some or all of the files in some directory, or (3) some or all of the files under some directory, recursively. These searches pop up a `*grep*` Buffer of clickable hits (each of which pulls up the file and takes you to that location).

Before we explain how to invoke the Greps, let's take a look at the workings of the `*grep*` Buffer; it works the same regardless of how it was invoked.

The `*grep*` Buffer and Grep Mode

You can see from the screenshot above that a `*grep*` Buffer looks just like an `*Occur*` Buffer—lines of hits prefixed with line numbers—except that the `*grep*` Buffer also includes file names; the format looks exactly like the output of `grep(1)`. Table 27 summarizes the buffer's key bindings. It shouldn't be surprising that the Buffer's *Grep Mode* has many key bindings and actions in common with Occur Mode; for historical reasons, there are some discrepancies in the key bindings, and Grep Mode also has some actions that don't make

sense in Occur Mode. See *Compilation Mode and its Many Descendants* for a side-by-side comparison.

Grep Mode is enabled in the *hits Buffer* (`*grep*`) and some of its actions affect one or more *target buffers* that it pops up for you.

Table 27: `grep-mode` Bindings

	Key	Action
1	`RET`, `C-c C-c`	jump to hit in target file
	`C-o`	display hit ...
	`n`	jump to Next hit in target file
	`p`	... Previous ...
2	`M-n`, `TAB`	move point to Next hit in `*grep*`
	`M-p`, `<backtab>`	... Previous hit ...
	`}`, `M-}`	move point to next file in `*grep*`
	`{`, `M-{`	... previous ...
	`C-c C-f`	toggle `next-error-follow-minor-mode` Mode
3	`SPC`, `S-SPC`	scroll target buffer up
	`DEL`	scroll target buffer down
	`<`	scroll target buffer to top
	`>`	scroll target buffer to bottom
4	`g`	revert buffer
	`C-c C-k`	Kill running `grep`
	`C-c C-p`	writable `grep`
5	`0 ... 9`	digit argument
	`q`	Quit hits buffer
	`h`, `?`	help for mode

The Grep Mode commands come in several groups:

1. Commands that visit the file containing the hit at Point in a pop-up Window, scroll the Window to the hit, and make this the selected Buffer so you're ready to edit. There's also a *display command*, `C-o`, to do all that but stay in the `*grep*` Buffer.

2. Commands that just move from hit to hit in the `*grep*` Buffer; you could of course use plain old `C-n` (`next-line`) and `C-p` (`previous-line`), but depending on your search, a hit might comprise more than one line. There are also handy commands to move from file to file, and a command to toggle `next-error-follow-minor-mode`.

3. Commands that scroll the target Buffer from within the `*grep*` Buffer; very handy when you've used `C-o`.

4. Commands to revert the `*grep*` Buffer (to re-run the `grep` command and update the Buffer); kill the running `grep` command[203]; or do an *Indirect Edit*.

5. The usual Special Mode conveniences: easy digit arguments, Mode help, and a quit command.

[203] If the scope of your `grep` is large, it might take minutes to finish.

`next-error` Integration

You can navigate from hit to hit from wherever you started your Grep *without* switching to the `*grep*` Buffer via `C-x ‘` (`next-error`) [204] or equivalently `M-g M-n` (they also work inside the `*grep*` Buffer). This works even when the `*grep*` Buffer is no longer visible.

[204] That's a *backtick*, not an apostrophe.

Indirect Editing with Writable Grep

One of the Grep facility's most amazing features is that you can edit the text of the hits in the `*grep*` Buffer and then, with a keystroke, write your edits back to the original files. This "indirect editing" feature works the same way as Writable Occur; unfortunately the keystroke to invoke it—`C-c C-p`— from a `*grep*` Buffer isn't the same as for an `*Occur*` Buffer.[205]

[205] Though you can always change that!

This requires the optional `wgrep` Package from the GNU repository. I recommend this snippet for your Init File:

Init File

```
(unless (package-installed-p 'wgrep)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'wgrep)))
```

Plain Old `M-x grep`

How do we acquire one of these wonderful `*grep*` Buffers? The fundamental way is with `M-x grep`, which will prompt you for a `grep` command line; so, this obviously assumes you're familiar with the Unix `grep(1)` command, *and* familiar with Regular Expressions (Regexps) as well. The default command line (on Linux) is:

```
grep --color -nH --null -e
```

You're expected to fill in your Regexp, and the paths of the files you want to search, at the right. Don't forget to quote both appropriately, just as in the shell. For example, you might edit the command like this:

```
grep --color -nH --null -e '^def ' *.py
```

in order to see the functions defined in all the `.py` files in the default directory.

You're free to change the options (perhaps adding a `-i` to do a case-insensitive search), but see below for details. You can also use something fancier than a single `grep` command, like a pipeline of

`grep`'s, or anything else that meets the requirements of the `*grep*` Buffer.

If you're unfamiliar with Regexps, you can change `grep` to `fgrep` and do a plain text search, but you still need to be familiar with Unix shell quoting; if you aren't, skip ahead to `lgrep`.

With a prefix argument, `C-u M-x grep` will fill in the complete `grep` command to search for the Symbol at Point in files matching the selected Buffer's file extension, so this is a good way for those unfamiliar with `grep(1)` to get started. And of course Emacs keeps a history of the `grep` commands you've used in this session, which you can access in the usual ways.

Local Directory Grep with `M-x lgrep`

`M-x lgrep` is a convenient front-end that composes a Grep command for you that searches all the files in a given directory; it's especially convenient for Emacs users who aren't yet *au courant* with Unix concepts like Regexps, shell quoting, and file globbing. When invoked, it prompts you for three things: a Regexp, a filename or glob pattern, and finally a directory, and it constructs and immediately runs a `grep` command for you. Let's use `M-x lgrep` to search for "foo" in all the files in our default directory. The Minibuffer prompts look like this:

```
Search for: foo
```

Now specify the files to search in:

```
Search for "foo" in files matching wildcard (default all):
```

Just hit `RET` for all (significant) files, but it's also totally fine to enter one or more filenames separated by spaces (your Completion system can help you), or use one or more space-separated glob patterns (wildcards).

Finally we have to say which directory contains the files:

```
In directory:
```

Hit `RET` to search the selected Buffer's default directory.

This will be a case-insensitive search by default. Don't try to quote any of these values; `lgrep` will quote them for you.

With a prefix argument, `C-u M-x lgrep`, you'll be able to edit the composed `grep` command before Emacs runs it; so you could change `grep` to `fgrep` here if you don't want to use a Regexp, for example. If you do this, you'll see that the composed command is *very* complex, because Emacs adds a boatload of options to ignore the types of files you don't usually want to include in a search (such as Emacs backup and auto-save files).

`lgrep` shares histories for each of the three prompts with `rgrep`.

Recursive Grep with `M-x rgrep`

`lgrep` does a flat search of files in one directory, but you can search an entire directory hierarchy recursively with `M-x rgrep`. It has the same three prompts as `lgrep` and the only difference is it also searches the starting directory's subdirectories, and so on, recursively. You can for example search your entire home directory by entering ~ as the starting directory.

`M-x rzgrep` is a variation that will search gzipped files[206]. You can specify them at the "files matching wildcard" prompt with the glob pattern `*.gz`, or be more specific with something like `*.org.gz`, or search both compressed and uncompressed files with multiple space-separated glob patterns (e.g., `*.org *.org.gz`). This command requires that you have `zgrep(1)` installed on your system. Since `rzgrep` is a confusing name, you can also invoke it by the alias `zrgrep`.

As for `lgrep`, with a prefix argument, you'll be able to edit the composed `grep` command before Emacs runs it.

[206] That is, files compressed by the `gzip(1)` program.

Just the Skeleton with `M-x grep-find`

`rgrep` composes a complex shell command that uses `find(1)` (the Unix directory hierarchy tool) to run the appropriate `grep` command for you. Like `lgrep`, the composed command ignores many files such as backup files. Occasionally you might not want this assistance; `C-u M-x rgrep` will let you edit the command, but it can be annoying to have to delete most of the over 1,500 characters to customize it. `M-x grep-find` gives the bare-bones, 57-character version of an `rgrep` command that you can edit to do precisely what you want. Needless to say, you'll need to be familiar with the very hairy (but essential) `find(1)` command for this.

Grep Files Aliases

When entering file names or glob patterns at the "files matching wildcard" prompt for any of `lgrep`, `rgrep`, or `rzgrep`, you can type any of a set of handy aliases that stand for more or less complex glob patterns. You can customize the variable `grep-files-aliases` to add your own shortcuts.

Alias	Generated Glob Patterns
all	* .*
am	Makefile.am GNUmakefile *.mk
asm	*.[sS]
c	*.c
cc	*.cc *.cxx *.cpp *.C *.CC *.c++
cchh	*.cc *.[ch]xx *.[ch]pp *.[CHh] *.CC *.HH *.[ch]++
ch	*.[ch]
el	*.el
h	*.h
hh	*.hxx *.hpp *.[Hh] *.HH *.h++
l	[Cc]hange[Ll]og*
m	[Mm]akefile*
tex	*.tex
texi	*.texi

Grepping from Dired

You can enlist Dired's help when you need to grep a very specific set of files that can't be specified by a compact glob pattern. Just mark the files via Dired's powerful marking commands, and then invoke `A` (`dired-do-find-regexp`).[207]

[207] Note that Dired's `A` command doesn't actually use the Grep facility, but rather the related Xref facility.

Which `grep` Is It, Really?

Any compatible program can be used with any of the Grep-family commands instead of plain old `grep`: in particular, you can use `egrep` or `fgrep` instead. What exactly makes a compatible command?

For `M-x grep`, where you specify the command invocation yourself, any command is compatible if it produces the standard grep output format, i.e. lines that look like:

```
FILENAME:LN:text
```

where `FILENAME` is the path to the file containing `text`, and `LN` is the number of the matching line. `grep(1)`, `egrep(1)`, and `fgrep(1)` are all capable of producing this output format.[208] Version control systems all support a `grep` subcommand and have options to produce a compatible format, like `git grep` or `hg grep`; these commands can be invoked via `M-x grep`, though there are also more specific ways to use them via third-party packages like Magit and Projectile.

Some popular grep replacements like `ag(1)`, `ripgrep(1)`, `ack(1)`, and the like, can be used as drop-in replacements, but they may be better used via third-party packages specifically designed for them.

[208] You won't get line numbers without the `-n` option, and note that by default, no `FILENAME` is output unless more than one file is named on the command line; you can toss in `/dev/null` to achieve this state; the GNU implementations support a `-H` option that assures the presence of the `FILENAME`.

The `lgrep` and `rgrep` commands also require this output format, but they additionally make assumptions about the availability of certain command line options, which is much more complex; to customize which `grep` program is used by these commands, Customize the variable `grep-template`.

Regular Expressions

> Some people, when confronted with a problem, think "I know, I'll use regular expressions." Now they have two problems. — Jamie Zawinski (comp.lang.emacs)

Regular Expressions (*Regexps*) have already come up several times in this book. Much as I've tried to avoid mentioning them up to this point, the fact is that they're used everywhere in Emacs: in Incremental Search, Query Replace, Grep, Dired, Apropos, and more.

If you're a programmer, an apostate from any other programmer's editor, or just a Unix user familiar with the standard command line tools, you'll already be familiar with the concept, and can skip ahead to see how Emacs Regexps differ from what you may be used to. If you're keen to learn and add Regexps to your tool kit (it'll be worth it, never mind Zawinski's cheeky remark), check out the References at the end of the chapter. But here I'll try to give an explanation of what they even are, and the minimum you need to know to make use of some Emacs Regexp-based commands.

Powerful Pattern Matching

The job of Regexps in Emacs is to enable more powerful searching and matching. Regexps are a mini-language for expressing patterns that describe, or match, sets of strings[209]. When you search for the word "Emacs" with the non-Regexp `C-s` (`isearch-forward`), you're actually using a pattern that happens to only match exactly one string: "Emacs". But you'll recall that, due to Case Folding, if you search for "emacs", you're using a pattern that matches a larger set of strings, including not just "Emacs" but also "emacs", "EMACS", "eMacS", etc. Thanks to Lax Space Matching, if you search for "GNU Emacs", it will also match strings like "GNU Emacs" or "GNU", a newline, and "Emacs" at the beginning of the next line. But that's about it for the pattern language of Isearch.

You're probably familiar with the common notation, or *syntax*, where a `*`-character or `?` is a *wildcard*, as in Unix shell *file globbing* patterns: you might write `*ing` to match files ending in "ing" or

[209] A *string* is what programmers call a sequence of characters; *foo* is a 3-character string, *a sequence of characters* is a longer string.

`c?t` to match files named "cat" or "cot". This means that you can't readily try to match strings that include asterisks or question marks, because of their interpretation as wildcards: they are not plain old characters, but what we call *metacharacters*, because they're functioning on a level above the literal.

Regexps are a *much* more powerful pattern language than that. They were formalized in 1951 by the mathematician Stephen Kleene and were probably first implemented in a text editor by Ken Thompson in QED sometime between 1967 and 1970[210]. From there they appeared in the original Unix editor `ed(1)` circa 1973; then, because of their general utility, in other tools like `grep(1)`; and then spread rapidly into every editor that's worthy of the name; they were in GNU Emacs from the beginning.

[210] As far as I know, Thompson invented the common basis of the modern syntax of Regular Expressions.

Regexps let you write compact, expressive, patterns that specify matches in terms of:

- beginnings and endings of lines and of strings
- beginnings and endings of words
- sets of characters (e.g. alphanumerics, vowels, whitespace)
- repetitions of Regexps (e.g. zero or more, between 3 and 12)
- grouping of sub-matches with the ability to refer back to them

In order to express these things, our notation needs to have eight metacharacters; here are the first seven (the Regexp `*` and `?` metacharacters do *not* have the same meaning they have as glob metacharacters):

```
. * + ? [ ^ $
```

In your Regexp you may well need to match one of these metacharacters *literally*: you can do this by *quoting* or *escaping* the metacharacter with the eighth metacharacter: the backslash, `\`. So `\*` is the Regexp that matches an asterisk, and a backslash can be used to quote itself by doubling it. But don't use backslash to quote plain, non-metacharacters, like `1`, `b`, or `w`, for example, where it may have a special interpretation; see *Backslash Constructs* below.

Knowing this, you can make use of Emacs commands that ask you to enter a Regexp, many of which are useful with plain non-meta, characters: just add a backslash to any of the eight metacharacters that you want to search for literally. Keep in mind that all characters except the eight metacharacters stand for themselves in a Regexp, so `Emacs` is indeed the Regexp that matches "Emacs" and `\*grep\*` matches "*grep*".

Here's how to translate file globbing patterns into equivalent Regexps:

Glob	Regexp	Interpretation
`*`	`.*`	zero or more of any characters
`?`	`.`	any single character
`[a-z]`	`[a-z]`	any one of the characters from `a` to `z`
`{a,b,c}`	`\(a|b|c\)`	either `a` or `b` or `c`

Note that `.`—we sometimes call that "dot"—"matches any character" just like `?` in file globbing, including punctuation and whitespace[211], for example. Other handy Regexps for matching text include `\b`, which matches a word *boundary* i.e. the beginning or the end of a word, and `\w`, which matches only *word constituents* (typically alphanumerics, though it depends on the Major Mode). So the Regexp to match words that start with an "e" and end with an "s" would be `\be\w*s\b`, which will match "Emacs", "editors", "examples", "es", and many others. That regexp translates to: match the strings which

[211] Except for newline: dot doesn't match newline.

1. at a word boundary (`\b`)
2. have an `e`
3. followed by zero or more word constituents (`\w*`)
4. followed by an `s`
5. at another word boundary (`\b`).

Unique Aspects of Emacs Regexps

If you're familiar with Regexps from non-Emacs contexts, you probably already know that there are several distinct Regexp syntaxes out there. Every application and programming language seems to have its own flavor with subtle differences from the others: there are the *basic* Regexps of `grep(1)`, the *extended* Regexps of `egrep(1)`, the heavily enhanced Regexps of `perl(1)` and the PCRE library, and so on.

You've probably guessed that I'm going to tell you that Emacs's Regexps are of yet another flavor. In the fundamentals, Emacs Regexps are more like `grep(1)` Regexps, in that `(`, `|`, `)`, `{`, and `}` and are ordinary characters and the backslashified versions are metacharacters. So in Emacs you do grouping (which captures) with `\(` and `\)`, alternation with `\|`, and counted repetition with `\{` and `\}`,

Emacs supports the non-greedy repetition operators `*?`, `+?`, and `??`, and the POSIX character classes (such as `[[:blank:]]`).

Emacs's `.` matches any character *excepting* a newline. To search for a newline, insert one literally with `C-j` (its ASCII value). You can also use the POSIX space character class (`[[:space:]]`) or the whitespace syntax class (`\s-`), when appropriate.

Backslash Constructs

Our Regexp notation, like most others, also includes a lot of *backslash constructs*, including many that are unique to Emacs, supporting purely Emacs concepts like the Buffer, Point, syntax classes, character categories, and symbols.

We have non-capturing ("shy") groups with `\(?: ...\)` and explicitly-numbered groups with `\(?NUM: ...\)`. `\sCODE` matches a character whose *syntax class* is `CODE`. So, for example, `\s-` matches any whitespace character, while `\sw` matches a word-character. `\SCODE` (note the uppercase "S") matches any character whose syntax class is *NOT* `CODE`.

The point of `\s` and `\S` is that the characters that comprise a given syntax class can differ from Major Mode to Major Mode[212]. So the word-class might include the apostrophe or it might not. Syntax classes let you write Regexps that work in any Mode. Table 28 lists the class codes.

[212] Really, from Buffer to Buffer.

CODE	Syntax Class
-	Whitespace characters
w	Word constituents
_	Symbol constituents
.	Punctuation characters
(	Open parenthesis characters
)	Close parenthesis characters
"	String quotes
\	Escape-syntax characters
/	Character quotes
$	Paired delimiters
'	Expression prefixes
<	Comment starters
>	Comment enders
@	Inherit standard syntax
!	Generic comment delimiters

Table 28: Regular Expression Syntax Classes

Some other unique Regexp metacharacters include `\`` and `\'` (that's backtick and apostrophe) to match at the beginning and end of the Buffer, respectively, and `\=` to match at Point. In addition to the common `\<` and `\>` to match the beginning and end of words, we also have `_<` and `_>` to do the same for symbols.

References

- See "Regexps" in the *Emacs* manual.
- Friedl, Jeffrey E. F. 2002. *Mastering Regular Expressions.* Sebastopol,

CA: O'Reilly..

Unlimited Undo with Redo

The ability to undo editing changes is fundamental. GNU Emacs had "unlimited" undo when it was released in 1985, a time when most editors had at most the ability to undo the single most recent change.

Just Undo It

It's very simple to just undo the last thing you did — whether inserting, modifying, or killing some text. Just hit `C-/` (`undo`), and your change is undone. Point is always moved to the location where the Undo occurred (which is why people use Undo to move around). After undoing, just continue with your editing.

If you invoke `undo` several times in a row, you'll see that it keeps undoing back in time. You can undo all the way back to the first change you made to the Buffer. If you visit a file, make changes, and then decide you don't like *any* of the editing you've done, you can Undo them all away (though this could be tedious and you'd be better off reverting the Buffer instead). You can Undo back through file saves, and you can even Undo your Undo's (see *Redo*, below).

To make undoing less tedious, Emacs groups long sequences of uninterrupted insertion into undoable chunks. So if you type "uninterrupted", and then hit `C-/`, the whole word is undone in one step, rather than requiring 13 invocations of `C-/`, one for each letter. This is called *amalgamation* and by default the chunk size is 20, so, if you type "antidisestablishmentarianism" you'll have to type two `C-/`'s to undo it.

Emacs puts `undo` on two additional keystrokes: `C-_` and `C-x u`, and of course you could always say `M-x undo`. `C-_` is the oldest of these key bindings (and is the one that's hardwired into my brain), but `C-/` is admittedly easier to type (`C-x u` is mnemonic, but highly unfelicitous).

What, When, and Where Can You Undo?

If you delete a word ("foo") in Buffer A, then delete a word ("bar") in Buffer B, and then, back in Buffer A, you hit `C-/`, the word "foo" comes back, even though the deletion in Buffer B was more recent. If you now change to Buffer B and Undo, "bar" comes back: each Buffer's undo history is independent.

Only changes to the *contents* of a Buffer are undoable. It doesn't matter what command caused a change: entering text by typing is undoable but so is any other command that enters text: yanking from the Kill Ring, inserting the result of running an external command with `C-u M-!` (`shell-command`), inserting a file with `C-x i` (`insert-file`): it's all undoable.

Any command that kills Buffer text is undoable, as is any textual object kill command like `M-DEL` (`backward-kill-word`). It makes no difference if you killed text with a keystroke, a mouse action, or a `M-x` (`execute-extended-command`) command.

All commands that modify text are undoable, like `M-t` (`transpose-words`) or `C-x C-u` (`upcase-region`). A command like `M-%` (`query-replace`) that makes mass changes is also undoable.

The *scale* of any of the above changes has no effect on their undoability. If you kill the entire Buffer contents with, say, `C-x h` (`mark-whole-buffer`) followed by `C-w` (`kill-region`), or change the whole Buffer to uppercase with `C-x C-u`[213], or insert the contents of a 3-megabyte file, a single Undo will happily undo the change.

[213] We've all been there…

It also doesn't matter how long ago you made a change; if you made a change to a Buffer a week ago, and your Emacs has been running all that time, you can still undo it. However, once you've killed a Buffer, its undo history is gone, and exiting Emacs of course kills *all* your Buffers.[214]

[214] However, the third-party package `undohist` will persist the undo history of all your file-visiting Buffers across sessions.

How Unlimited is Unlimited?

Actually, there *are* limits, changeable, to the Undo facility. The defaults are so big that Undo is *effectively* unlimited.[215]

[215] Myself, I have never hit these limits. At least, I've never noticed it!

How far back you can Undo is controlled by two User Options; there's also a hard limit on the maximum size of any single change (see `undo-outer-limit`). You can Customize all of these. See "Undo" in the *Emacs* manual for details.

Undo in the Region (Selective Undo)

The most amazing feature of Undo is that you can limit your Undoing to a subset of the Buffer. Imagine that you've been editing for an

hour, and then decide that you don't like the changes you made to one paragraph thirty minutes ago — but you *do* like all the rest of your changes. It would be awful to have to Undo everything you've done in the last twenty-nine minutes just to restore that one paragraph.

No problem: all you need to do is set the Active Region around that paragraph and start Undoing. None of the work you've done outside of that paragraph will be Undone, and Undo will stop if you go all the way back to the first change you made to that paragraph.

Redo, or Undo the Undos

It's very easy to overshoot when you're Undoing. You're typing at speed, make a mistake, and hit a few `C-/`'s to Undo it. But you hit one too many! You can't just immediately type `C-/` again: that would just Undo one step further. What to do?

You just have to *stop Undoing*. Not for a length of time, but just by issuing *any* Emacs command that isn't `undo`. You could invoke `C-f` (`forward-char`), a nice harmless command, or `M-x calendar`, or anything else, but `C-g` (`keyboard-quit`) is a perfectly fine way to stop Undoing (and by now it's probably wired into your lizard brain as the "oops" command).

So after `C-g` just Undo again with `C-/` and it does the same thing as always: undoes the last change to the Buffer, which happens to be your superfluous Undo. The distinction between Undo and Redo may take a little getting used to, so play around with it. (If you can't get used to it, see `undo-tree`.)

What Can't You Undo?

You can't Undo anything that's not a change to the *contents* of a Buffer. So you can't Undo changes to the layout of your Windows, like a `C-x 0` (`delete-window`) or a `C-x 2` (`split-window-below`), or a switch from one window to another. (But a recommended separate facility allows you to undo those changes.)

You also can't Undo killing a Buffer, which is another reason Emacs is careful to ask for confirmation if you try to kill an unsaved file-visiting Buffer.[216]

[216] And why you shouldn't take notes in non-file-visiting Buffers; see *Ubiquitous Capture*.

Don't confuse the contents of the Buffer with how it's presented: if you highlight a word with `M-s h .` (`highlight-symbol-at-point`), changing it's color to yellow, that doesn't change the actual text at all, and so is not undoable with the Undo facility (of course, you can "undo" the highlight manually).

You can't Undo the deletion of a file with `M-x delete-file` or

Dired's `D` (`dired-do-delete`) command, or anything else like that; that's the province of your Version Control system.

Certain Buffers don't have Undo turned on; any Buffer whose name starts with a space (see *Hidden Buffers*) has Undo turned off. You can turn Undo off in any Buffer if you like, but why would you?

`special-mode` Buffers (and Buffers in Modes that inherit from `special-mode`), which are read-only by default and usually implement applications, may or may not implement Undo.

Finally, you can't Undo non-Emacs actions that Emacs takes for you, like sending an email, an instant message, or a tweet!

The `undo-tree` Alternative

A fair number of people think that the way Undo works is one of the most confusing things about Emacs, right up there with the workings of the Kill Ring. And just like the latter, there are alternatives available (thanks to the extensible nature of Emacs).

The `undo-tree` package is the most popular alternative. Instead of a linear list of changes that (confusingly?) includes undos, it organizes the undo history as a branching tree, which makes it easier to understand. The author cheekily asserts:

> The only downside to this more advanced yet simpler undo system is that it was inspired by Vim. — Toby Cubitt

It's an impressive package and it can coexist with standard Undo (you can switch back and forth, or set up separate key bindings) but I find it to be more intrusive than the default Undo, especially if you turn on its visualizer and integrated diff (which is what makes it especially easy to understand). See the screenshot at the Emacs Wiki. Personally, I think with a little practice you can get completely comfortable with standard Undo. But if you want `undo-tree` just add the following snippet to your Init File:

```
(unless (package-installed-p 'undo-tree)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'undo-tree)))
;; to replace standard Undo everywhere
(with-demoted-errors "%s" (global-undo-tree-mode))
```

Approaching Programming: Keyboard Macros

> I believe I can state without the slightest hint of exaggeration that Emacs keyboard macros are the coolest thing in the entire universe. — Steve Yegge

Thanks to its nature as a Lisp Machine, Emacs is probably the most completely customizable and extensible piece of software in existence. Emacs is written in Emacs Lisp (Elisp) running in a Lisp interpreter that you can modify in real time, as it runs, to change almost anything, and any brand new code you write can run immediately, and interact with all the rest of Emacs itself.

This is fantastic and amazingly powerful. The only problem is, you need to be an Elisp programmer to do it! We'll address the goal of becoming an Elisp programmer in in *Programming the Lisp Machine*, but in this chapter, we'll talk about how you can do some programming with no Elisp skills.

Nothing is more tedious than manually making repetitious mass edits to a file or files. `M-x query-replace` and especially `M-x query-replace-regexp` can handle relatively simple cases, especially if coupled with any of the Greps and Writable Grep, or Writable Occur; Dired's `Q` (`dired-do-find-regexp-and-replace`) command is also available, and the Xref facility can do mass renames of identifiers in your program source code.[217]

[217] Other tools for mass edits include Rectangles and the third-party Multiple Cursors package.

But some mass edits are too complicated for any of those solutions.

A *Keyboard Macro* (hereafter, a *Macro*) is a shorthand way of re-executing a longer sequence of commands. A function in a programming language (like Elisp) can be thought of in exactly the same terms, but to write one you have to compose the function in a Buffer[218], and evaluate it (assuming you know the syntax and semantics of the language).

[218] Possibly the Minibuffer…

Instead, a Macro is quickly defined at the point where it's needed: you tell Emacs to start recording, embark on a sequence of commands (key strokes) to perform one instance of your task, and then stop recording. Now you can immediately re-run those steps, whether once or twice or by telling Emacs to run the Macro as many

times as it takes to do all the repetitions. Then you just forget about it.

Or instead, you might re-run the macro hours (or days) later, assuming you haven't exited Emacs, and if the Macro has turned out to be generally useful, you can save it for future sessions, optionally giving it a name and possibly binding it to a key. You can have several anonymous Macros defined in your session and switch between them, and you can edit any of them to fix a bug or make an enhancement.

Note that Macros are defined *globally* and are not Buffer-local. You can define a Macro in one Buffer, and then switch to a different Buffer to execute it.

Your First Macro

Suppose you have a list of author names in inverted form and want to change them all to a different format:

```
Brackett, Leigh
Durrell, Gerald
O'Brian, Patrick
Ambler, Eric
Fleming, Fergus
Mundy, Talbot
```

Instead of "Brackett, Leigh" you want "Leigh BRACKETT", and so on.

In order to make these changes with a Macro, you just have to do the first one while recording, and then all rest can be done automatically.

Here's my algorithm. I have to start by positioning Point at the beginning of the list. Now I perform these steps:[219]

`M-u (upcase-word)` giving "BRACKETT"

`C-d (delete-char)` eliminating the comma

`M-t (transpose-words)` flip the two parts

`C-f (forward-char)` move to the beginning of the next line

To turn this algorithm into a Macro and apply it, you only need to learn three things:

1. how to start recording,
2. how to stop recording, and

[219] Interestingly, I used a Macro to generate this list of steps from the recorded Macro definition!

3. how to invoke the Macro you just defined.

You start recording with `C-x (`; you'll see the message "Defining kbd macro..." in the Echo Area and the indicator "Def" will light-up in the Mode Line until you're done. Now you perform the actions that comprise your Macro, any sequence of commands of any length; now you've done the first of presumably many repetitions of your task.

You stop recording with `C-x )`; you'll see "Keyboard macro defined" and the "Def" indicator will go away.

Now you can invoke the macro with `C-x e` (`kmacro-end-and-call-macro`): it re-executes your sequence of commands. Since we ended the Macro by moving to the beginning of the next line, we're ready to invoke it immediately without having to move into position. We'll call `C-x e` five more times, and the result will be:

```
Leigh BRACKETT
Gerald DURRELL
Patrick O'BRIAN
Eric AMBLER
Fergus FLEMING
Talbot MUNDY
```

Repeating a Macro

Perhaps you noticed this message in the Echo Area after your first `C-x e`:

```
(Type e to repeat macro)
```

After any `C-x e` you can immediately rerun the Macro by just typing `e`.

You can also have Emacs repeat the Macro for you. You can give `C-x e` a numeric argument, and Emacs will repeat it that many times. Occasionally it's obvious how many times you need to invoke a Macro, but it's much more common that you just know you need to invoke the Macro *a lot*. It's very common to want to reapply the Macro as many times as possible, all the way to the end of the Buffer.

You can auto-repeat the Macro by giving `C-x e` a numeric argument of zero (standing for infinity) as in `C-u 0 C-x e`. The Macro will just repeat over and over until it gets an error (which will usually happen at the end of the Buffer) or until interrupted with `C-g` (`keyboard-quit`).

If you want to apply a Macro to a big chunk of text, but not the whole Buffer, just Narrow the Buffer with `C-x n n`, go to the beginning of the narrowed region and invoke the Macro infinity times.

When it beeps, having hit the end of the (narrowed) Buffer, you're done, and you can widen it again with `C-x n w`.

It *is* possible to define a Macro that loops infinitely! A simple example is:

```
C-x ( foo C-x )
```

In other words, a Macro that just inserts "foo". If you `C-u 0 C-x e` this Macro, it will just insert one "foo " after another, forever, until you fill up all of memory and maybe crash your Emacs — welcome to Computer Programming! Best only to use `C-u 0` with a Macro that can fail (like a Macro that includes a search).

Aborting a Macro Definition

If you need to abort the definition of your Macro, perhaps because you realize your algorithm isn't exactly right, all you need to do is hit `C-g` (`keyboard-quit`). This terminates the Macro definition mode and discards all the steps you just recorded. It does *not* undo all the commands you invoked however, so if you want to start your definition over from scratch, you'll have to Undo. If you want to pick up your aborted Macro definition and fix it without having to redo the whole thing, see `C-x C-k l` (`kmacro-edit-lossage`) below in *Editing Your Macro*.

Line-by-Line Macros

Many Macros, like our example, are intended to be applied to a line at a time; that's why we used `C-f` at the end, to advance to the beginning of the next line. But there's a special command to simplify both the definition and execution of this kind of Macro.

You just define your Macro, starting at the beginning of the first line, without worrying about ending up at the beginning of the next line; then, definition finished, you set the Region around any sequence of target lines, and invoke `C-x C-k r` (`apply-macro-to-region-lines`). This invokes your Macro exactly once on each line of the Region; it automatically positions Point at the beginning of each line before each repetition. So with `C-x C-k r` our Macro could be as simple as `M-u C-d M-t`.

What Happens If You Make a Mistake?

As you're defining, if any command you invoke raises an error, the definition will be aborted. The steps that comprise your Macro have

to be error-free. By far the most common such error must be searching for some text that doesn't actually exist.

Searches are a very common part of many Macros; often you use a search to get to the next place in the Buffer that you want to change. The natural effect of this is to terminate automatic repetitions of your Macro when there are no more matches, so that kind of error is not only okay, but a key part of Macro design. But often you'll discover that your search is perhaps too specific and the resulting error will blow up your Macro early; you'll just have to come up with a better search.

Remember that Undoing is just another Emacs command, so you if make a non-error-raising mistake while defining, you might be able to just Undo it rather than starting over! In our example above, what if instead of upcasing the name I accidentally downcased it? Instead of aborting and starting over I could just immediately Undo and then do the upcasing I intended. The Macro would now be: `M-l C-/ M-u C-d M-t C-f`, which is, I suppose, less efficient, but it will work just as well.

Speaking of mistakes, while you *can* (technically) use the mouse in defining a Macro, I think it's a bad idea. The mouse is a very complex device, its effect depending on exactly where the mouse cursor is at the moment, so replaying mouse events is very unreliable.

Minibuffer Prompts

If in defining your Macro you invoke a command that prompts you for input via the Minibuffer, then when the Macro is run, you will *not* be prompted again: the command will use the same text you entered during definition. This is usually what you want. For example, suppose your Macro is gathering text from the current Buffer and saving it in another Buffer via `M-x append-to-buffer`, which prompts you for the name of the other Buffer: if you need to run that Macro a hundred times, you don't want to have to retype the Buffer name each time!

Because of this behavior, it's also common to just define a Macro that invokes a single `M-x` command that you are about to use several times; defining:

```
C-x ( M-x append-to-buffer RET stuff RET C-x )
```

means you can just say `C-x e` to gather some text, rather than the long-winded `M-x append-to-buffer` plus at least a `M-p` to pull up the Buffer name you're using.

There's one thing to keep in mind though: in entering something like a Buffer name, you should be conservative in exploiting the con-

veniences of your Completion framework! In normal Emacsing, you might enter a Buffer name by typing only a few letters and hitting return when Completion presents the right name. If you do this in a Macro definition, the next time you run the Macro you might get a different, unintended, Buffer name! This is most likely to happen with a Macro that you run intermittently throughout a sesssion: perhaps your Completion framework offers up matching Buffer names in a different order depending on how recently you used them. It's good Macro practice to type out the whole name explicitly in this scenario.

The Keyboard Macro Map

Table 29: Keyboard Macro Commands

Keystrokes	Category	Action
`C-x (`	Define	start defining a Macro
`C-x C-k s`		… the same
`C-x C-k C-s`		… the same
`<F3>`		… the same
`C-x )`		end Macro definition
`<F4>`		… the same (if defining)
`C-x e`	Execute	Execute latest Macro
`<F4>`		… the same (if not currently defining)
`C-u <F3>`		execute latest Macro and append new commands
`C-x C-k r`		apply Macro line-by-line in Region
`C-x C-k C-n`	Ring	make earlier Macro the current Macro
`C-x C-k C-p`		… reverse direction
`C-x C-k C-d`		Delete the current Macro from the Ring
`C-x C-k C-v`		View current Macro definition
`C-x q`	Query	Query the user
`C-x C-k q`		… the same
`<F3>`	Count	Insert Macro counter value at Point
`C-x C-k C-i`		… the same
`C-x C-k C-c`		set the Counter's value
`C-x C-k C-f`		define the counter's Format
`C-x C-k C-e`	Edit	Edit the current Macro definition
`C-x C-k RET`		… the same
`C-x C-k e`		Edit a Macro by its *name* or *binding*
`C-x C-k l`		turn the Last few commands into a Macro
`C-x C-k SPC`		edit (debug) the current Macro step-by-step
`C-x C-k b`	Bind	Bind the current macro to a keystroke
`C-x C-k n`		Name the current macro for `M-x`
`C-x C-k x`		store the current macro in a register

There's a whole family of Macro commands on the `C-x C-k` prefix,

and a few other handy key bindings as well. In Table 29 I've gathered them in several groups. Let's take a look.

Macro Definition Commands

Instead of the `C-x (` and `C-x )` commands I've been using above, you should probably use the quicker and cleverer `<F3>` and `<F4>`.[220] These two commands are context-sensitive. `<F3>` begins a Macro definition just like `C-x (` and `<F4>` terminates a Macro definition just like `C-x )`, but if you're *not* in the middle of defining a Macro, `<F4>` instead *executes* the Macro like `C-x e` does, and since it's a single keystroke, you can felicitously re-invoke it several times in row; hence, it doesn't need the "(Type e to repeat macro)" trick. So with these keys, whipping up and executing a Macro is as simple as: `<F3>` *defining commands* `<F4> <F4> <F4> ...`.

[220] I learned `C-x (` and `C-x )` decades ago and didn't really know anything about `<F3>` and `<F4>` until I started researching this chapter...

If you give `<F3>` a `C-u` prefix i.e. `C-u <F3>`, it allows you to *extend* the definition of your current Macro: it executes the Macro once but then reenters definition mode, allowing you to add more commands to the end of definition. Terminate this extension with `<F4>` as usual and the next time you execute it, your added commands will be included.

This is a simple way of *editing* your Macro (for more elaborate editing see *Editing Your Macro* below).

You can also think of it as allowing *incremental definition*: define your Macro in stages. Going back to our author-name-reformatting Macro above, we could have defined as before:

`<F3>` start defining

`M-u` upcase last name

`C-d` delete comma

`M-t` transpose words

`<F4>` done!

But now after trying it a couple times, we might decide that we really want to add a "bullet" at the beginning of the line, so we can extend the definition:

`C-u <F3>` append commands to Macro definition

`C-a` go to beginning of line

`+ SPC` add a "bullet"[221]

`<F4>` done!

[221] Leading +-signs render items as a bullet list in Org Mode markup.

Now our remaining author names will come out like this:

```
+ Lynda BARRY
+ Ian FLEMING
```

The Macro Ring

You can have any number of Macros defined simultaneously.[222] They are stored in a typical Emacs ring structure, so if you define a second Macro in your session, it's pushed onto the front of the Macro Ring, eclipsing your previous definition. From now on, all Macro invocations via <F4> and friends execute the new one.

Unless you rotate the Macro Ring of course! To execute your previous Macro, do C-x C-k C-n (kmacro-cycle-ring-next).[223] The previous Macro's definition will be shown in the Echo Area; it's a mite cryptic, but you should be able to recognize it since you defined it recently! Here's how our extended author-name-reformatting Macro appears:

```
Macro: M-u C-d SPC M-t C-a + SPC
```

Repeating C-x C-k C-n will cycle around the Ring; just stop when you've found the Macro you want and now <F4> will execute *that* one instead, and keep executing that one until you rotate again or define a newer one.

If you overshoot in your cycling, C-x C-k C-p (kmacro-cycle-ring-previous) will reverse direction. You can quickly delete the current Macro with C-x C-k C-d (kmacro-delete-ring-head), and there are a few more Macro Ring commands and a mechanism for shorthand keystrokes, but these are for real professionals: I've never had a complex-enough set of Macros to have needed them; see "Keyboard Macro Ring" in the *Emacs* manual.

You can review the Macros in the Ring with C-x C-k C-v (kmacro-view-macro-repeat); it displays the definition in the Echo Area without actually rotating the Ring; an immediate C-v cycles to show the next. While you're cycling, you can execute the currently-displayed Macro by immediately typing C-k, without having rotated it to the front of the Ring.[224]

If you really need to use several different Macros at a time, you might find it easier to just bind them explicitly to keys, or give them names; see *Naming and Binding Your Macros*.

Macro Query

Keyboard Macros really are a programming language, but they do seem like they're not a Turing Complete one, since they're lacking the necessary conditional statement.[225] However, the handy C-x q

[222] Well, you can set kmacro-ring-max to be as big as you like; the default is only 8, which has always been plenty for me.

[223] I know, "next" gets "previous"? Is the snake eating its tail or is the tail being eaten by the snake? Everything is relative.

[224] The C-k has to be entered *immediately* after a C-x C-k C-v or else it's just a normal C-k (probably kill-line!).

[225] Of course, you can always reach out to Elisp within a Macro via M-: (eval-expression) and the like.

(`kbd-macro-query`) command directly supports a limited amount of conditional or dynamic action within your Macro.

The most basic function of `C-x q` is to stop at a certain point and ask you if you want to continue with the Macro. Suppose we're about to define our author-name-reformatting Macro, but we know in advance that we only want to apply it to *some* of the lines in the Region. We could just live with not being able to run it over the whole Buffer automatically (via `C-x C-k r` (`apply-macro-to-region-lines`)) and invoke it manually one line at a time. But we could instead begin the Macro with `C-x q` i.e. `C-x q M-u C-d M-t`.

Each time we run the Macro, `C-x q` will ask in the Minibuffer:

```
Proceed with macro? (Y, N, RET, C-l, C-r)
```

and wait for a response, which can be any of the following:

Key	Action
`Y`	Finish this iteration normally and continue with the next.
`N`	Skip the rest of this iteration, and start the next.
`RET`	Stop the macro entirely right now.
`C-l`	Redisplay the screen, then ask again.
`C-r`	Enter recursive edit; ask again when you exit from that.

If we're running the Macro with `C-x C-k r`, We can respond `Y` on the lines where we want to apply the Macro, and `N` where we don't.

Most powerful is that we can enter a Recursive Edit, which would allow us to make a local, manual, tweak in each execution.

Macro Counters

Every Macro has its own *counter* which you can use to number things while it executes. Perhaps instead of a bullet list of reformatted authors, we want to make a numbered list. All we need to do is use `C-x C-k C-i` (or `<F3>`, which is equivalent when you're already defining) at the appropriate spot in our definition: `C-x C-k C-i . SPC M-u C-d M-t`. Now when we run our Macro with `C-x C-k r` the result is:

```
0. Gerald DURRELL
1. Patrick O'BRIAN
2. Eric AMBLER
3. Fergus FLEMING
4. Talbot MUNDY
```

If you move around or do other things and then `<F4>` your Macro again, it will continue with number 5. You can reset the count with `C-x C-k C-c` (`kmacro-set-counter`).[226]

[226] Practically speaking, if you really just want to number lines, the easiest way is with `C-x r N` (`rectangle-number-lines`); see *Rectangles*.

I'm sure you've noticed that the Macro Counter starts at zero... That's because programmers count from zero. If you're not a programmer, or you're a programmer who wants to act like a normal human at this moment, just set the Counter to 1 before you invoke the Macro for the first time: `C-u 1 C-x C-k C-c`.

In addition to its Counter, each Macro also has it's own Counter Format. You can change it by calling `C-x C-k C-f` (`kmacro-set-format`) at the beginning of your definition.[227] This allows you to get leading zeros or spaces for a fixed-width number column:

[227] If you call it outside of definition mode, it will set the default format for all subsequent Macro definitions.

```
0013. Eric AMBLER
```

or even number your list in hexadecimal. If you're a programmer, you'll have guessed that this uses a `printf` format string; see "Formatting Strings" in the *Elisp* manual.

Editing Your Macro

In the old days, it was inevitable that after (or during) the definition of an elaborate Macro, you would discover a mistake; there was nothing to do but start over from scratch. But we 21st century Emacsers have `C-x C-k C-e` (`kmacro-edit-macro-repeat`) and can *edit* our definition to correct it, or further enhance a working Macro.

We've seen `C-u <F3>`, but that's just a poor man's approximation[228] that only allows you to append new commands to the end. `C-x C-k C-e` pops up a special Buffer `*Edit Macro*` that displays the definition line-by-line with explanatory comments, and you can delete steps, rearrange them, and add new steps at will. Let's edit our author-name-reformatting Macro. `C-x C-k C-e` edits the current Macro (at the front of the Ring), so if the one you want to edit isn't there, rotate the Ring appropriately,

[228] Or a handy shortcut, if you're feeling generous.

```
;; Keyboard Macro Editor.  Press C-c C-c to finish; press C-x k RET to cancel.
;; Original keys: C-x C-k C-i . SPC M-u C-d M-t

Command: last-kbd-macro
Key: none

Macro:

C-x C-k C-i           ;; kmacro-start-macro-or-insert-counter
.                     ;; self-insert-command
SPC                   ;; self-insert-command
M-u                   ;; upcase-word
C-d                   ;; delete-char
M-t                   ;; transpose-words
```

Note that there are several Elisp comments in this Buffer: everything from a semicolon to the end of the line is a comment. These comments are insignificant to your Macro editing; nothing you might change in a comment here (including deleting it entirely) has any effect. In general, differences in whitespace are also insignificant.

The defining parts of the Buffer are the non-whitespace characters following the word `Macro:` (and ignoring the comments). Each command in the definition consists of the keystrokes used to invoke it, spelled the way Emacs spells them when you use `C-h c` (`describe-key-briefly`) (which is the way you see these keys spelled throughout this book). So `SPC` for the Space key, `RET` for Return, etc. Remember, amounts of whitespace (including line breaks) make no difference: the definition could be all on one line like:

```
C-x C-k C-i . SPC M-u C-d M-t
```

the three keystrokes `C-x C-k C-i` could be split across three lines, etc.

If you repeat a command several times in a row, you might see this format:

```
4*M-u   ;; upcase-word
```

which means you typed four `M-u`'s here; you can use this notation yourself.

Suppose you want to change your Macro to merely capitalize the author's last name instead of uppercasing all of it. Just change `M-u` to `M-c` (`capitalize-word`) and hit `C-c C-c` to save your change. Simple as that: now instead of "Eric AMBLER" you'll get "Eric Ambler".

Note that the `Original keys` section at top preserves the original definition in a comment; you can grab bits of it if needed. Additionally, the `*Edit Macro*` Buffer is a Buffer like any other you might edit, so of course you can use Undo within it. But if you do mess up or change your mind, you can always just bury or kill the Buffer and your Macro remains unchanged.

If you've named or bound your Macro to a key (see below), you can edit it with `C-x C-k e` (`edit-kbd-macro`). And you can also turn a sequence of editing commands you just happened to type into a Macro after the fact with `C-x C-k l` (`kmacro-edit-lossage`), which pops up an `*Edit Macro*` Buffer loaded with the last 300 keystrokes you typed (you'll almost certainly delete a lot of them).

Debugging Your Macro

Real programming languages have interactive debuggers to help you find bugs in your programs[229], typically by *single-stepping* through the code: that is, running the program one instruction at a time so you can see the effect of each one clearly and incrementally.

[229] Elisp has two built-in debuggers.

Surprisingly, Emacs also has a debugger for Macros![230] Position yourself for the execution of your Macro but instead of `<F4>` or `C-x e`, run it with `C-x C-k SPC` (`kmacro-step-edit-macro`), Emacs will pop up a small Window showing the definition of your Macro, and give

[230] I was certainly surprised when I discovered this in writing this chapter!

you a prompt. If you type `SPC` at the prompt, it will execute the first command of your Macro — you'll see the effect in the original Buffer — and prompt you again. If you type `SPC` for every command in the definition, you will have executed the Macro just as if you had typed `<F4>`: only much more slowly!

This slow stepwise execution can reveal to you a bug in your Macro, which you could then fix with the Macro editor (`C-x C-k e`). But at each step, you can instead skip the current command, or insert a new series of commands before or after it: any such changes you make are saved and become part of the Macro's definition, so this is also a more interactive and perhaps intuitive way of *editing* your Macro. See "Keyboard Macro Step-Edit" in the *Emacs* manual for detailed instructions.

Naming and Binding Your Macros

If the Macro Ring seems a little too ascetic to you, you can easily bind your latest Macro to a key with `C-x C-k b` (`kmacro-bind-to-key`). This cautious command will prompt you for a keystroke; if you choose one that's already in use, it will ask you if you're sure you want to replace that binding with your Macro.

Since there are something between 200 and 1,000 active key bindings in a typical Emacs, you might have trouble coming up with an unused keystroke! As a convenience, if you type any of the digits 0-9 or the capital letters A-Z, your Macro will be bound to that key in the `C-x C-k` keymap. So if you type `C-x C-k b` and repond `Q`, your Macro will be bound to `C-x C-k Q`.

With `C-x C-k n` (`kmacro-name-last-macro`) you can instead, or also, give your Macro a long name that you can use with `M-x` (`execute-extended-command`).

Both of these binding commands only last until the end of this Emacs session. If you want to save your Macro permanently, pull up your Init File, jump to the end of it, and invoke `M-x insert-kbd-macro`; this command will prompt for the name of your Macro[231] and convert it to Elisp, which it will insert into the current Buffer at Point. It might look a little cryptic; here's one possible form for our author-name-reformatting Macro:

[231] You have to have named it first...

```
(fset 'reformat-author-name
   (kmacro-lambda-form [escape ?u ?\C-d escape ?t] 0 "%d"))
```

If you gave your Macro a key binding as well as a name, you can use `C-u M-x insert-kbd-macro` instead, which will also save your key binding:

```
(fset 'reformat-author-name
   (kmacro-lambda-form [escape ?u ?\C-d escape ?t] 0 "%d"))
(global-set-key [24 11 81] 'reformat-author-name)
```

With this code in your Init File, your Macro will be available every time you begin an Emacs session.

A Musical Example

Let's finish up with one more example. I play the ukulele and guitar and have hundreds of files of *lead sheets*. I usually write them out in this format: song lyrics with the chords written above the lines, like so:[232]

[232] The Verlaines: "Anniversary" (*Some Disenchanted Evening*, 1989)

```
        A             D             A7        Gbdim
And she said, "By the time that you open your eyes
           G        D7          G
There will not be a shoulder in sight."
```

This is convenient for editing, but when I'm done with a song, I want to convert it into the de facto standard ChordPro format (which is harder to edit):

```
And she [A]said, "By the [D]time that you [A7]open your [Gbdim]eyes
There will [G]not be a [D7]shoulder in [G]sight."
```

Obviously converting from the former to the latter calls for a Macro; here's the one I whipped up:

```
C-e     ;; move-end-of-line
M-\     ;; delete-horizontal-space
C-u -   ;; self-insert-command
M-C-k   ;; kill-sexp
C-n     ;; next-line
[       ;; self-insert-command
C-y     ;; yank
]       ;; self-insert-command
C-p     ;; previous-line
```

After using this for a while, I made some tweaks to it; then I turned it into an Elisp function to make it more robust; and ultimately it grew into a Major Mode for editing ChordPro files.

The Customize Facility

The simplest kind of Emacs customization is to change the value of any of the 2,980 User Options or Faces. While an Elisp programmer might choose to do this via an Elisp expression in the Init File, it's very easy for the non-programmer to do via the interactive *Customize* facility, which presents the variable's default value, its current value, its legal *possible* values, its documentation, links to related variables, and an easy interactive way to modify the value.

One of the big advantages of Customize over customization via Elisp, even for experienced Elisp programmers, is the amount of bookkeeping that Customize does for you. It keeps track of what you've customized, allowing you to restore or further tweak the value of something you changed and now regret.

Entry Points

The entry points to the Customize facility range from customizing one single Variable or Face, up to high-level browsing of everything customizable; Table 30 summarizes most of them.

Table 30: Customization Commands

`M-x customize-variable`	Customize a single named User Option
`M-x customize-variable-other-window`	... in the other Window
`M-x customize-face`	Customize a single named Face
`M-x customize-face-other-window`	... in the other Window
`M-x customize-mode`	Customize all Variables related to a major or minor mode
`M-x customize-group`	Customize *GROUP*, which must be a *customization group*
`M-x customize-group-other-window`	... in the other window
`M-x customize`	Customize anything or everything
`M-x customize-browse`	... same, via a tree-structured interface
`M-x customize-apropos-options`	Customize all loaded Options matching a *REGEXP*
`M-x customize-apropos-faces`	Customize all loaded Faces matching a *REGEXP*
`M-x customize-apropos-groups`	Customize all loaded groups matching a *REGEXP*
`M-x customize-apropos`	Customize loaded Options, Faces and groups matching a *PATTERN*

(`customize-variable` also goes by the name `customize-option`, and `customize-variable-other-window` is also known as `customize-option-other-window`.)

A Package has to be loaded before you can Customize it. If you try to Customize a User Option, and `customize-option` won't Complete the variable name, that probably means you haven't yet loaded the Package. Most Variable and Function names begin with the name of the Package. Say you're trying to Customize `crossword-auto-check-completed`; the Package that contains this function is `crossword`; this will almost always be the case. So just do `M-x load-library RET crossword` and you will then be able to Customize the Variable.

To aid browsing and navigation, customization Variables are organized in *groups*; often each Emacs package in the Package Manager defines its own group, but there are also broader groups defined. `M-x customize-group` let's you see all the Variables and Faces for such a group; `M-x customize-group RET isearch` will show you everything you can change about Incremental Search, for example: around 40 Options . While you can discover the Customization groups via Completion on `M-x customize-group`, if exploration is your goal you can use `M-x customize` and navigate through all the groups and subgroups in a leisurely manner.

You can also enter the facility via Apropos. Suppose you want to tweak the options relating to how sentences are recognized, but you don't know the name of the appropriate group. `M-x customize-apropos` with the keyword "sentence" will bring up five pertinent Variables.

Experiment Without Fear

You don't have to worry very much about entering the Customize facility and messing things up. All the changes you make happen in three steps: first *editing* a value, then *setting* it (which causes it to take effect in this session), and finally *saving* the change for future sessions. You can feel free to edit a value just to see what it looks like: doing so won't have any effect unless you also *set* it. If you've edited a value and it looks undesirable to you, you don't even have to restore it if you haven't set it yet. You can simply kill the Buffer, or bury it and never come back; it will be as if you were never there. And if you *have* set it, Customize remembers the previous value and makes it easy to restore it. It's even easy to find changes you've saved for all future sessions and restore them, if it turns out you don't like something you've done.

Changing the Value of a Variable

Depending on which entry point you've chosen, the Customize Buffer will have one or possibly many Variables or Faces you can

change.

Let's consider doing `M-x customize-variable RET list-command-history-max` (see *The Minibuffer*). In the Customize Buffer, we'll see something like:

```
List Command History Max: [Value Menu] Integer: 32
   [State] : STANDARD.
   If non-nil, maximum length of the listing produced by 'list-command-history'.
```

We can see the name of the Variable[233], its current value (here 32), its customization *state* (here "STANDARD"), and its documentation.

You can change the value by editing the current value in the Buffer (just change the 32 to something else) or by *clicking*[234] the "Value Menu" button.

Some Variables are simple and only accept a single sort of value (say, a number or a string), but others have more complex possibilities, and the Value button gives you a way of unambiguously entering them: Boolean variables can toggled on or off, for example, and it's very common for Variables to allow an out-of-band *nil* option that can be interpreted in a variety of ways (described in the Variables's documentation).

It's also very common for a Variable to take a complex value, like a list of things; in this case, there will be additional buttons to add or delete individual elements of the list. See "Changing a Variable" in the *Emacs* manual for complete details.

When you change the value, whether by clicking or editing, the State button will change from "STANDARD" to "EDITED". To actually apply your edit you need to *set* the value. Click on the State button and you'll see a menu of options:

Set for Current Session
Save for Future Sessions
Undo Edits
Revert This Session's Customization
Erase Customization
Add Comment

The first two should be self-explanatory; "Undo Edits" restores this Variable to the value it had when you entered the customization Buffer; "Revert" restores the value to the last saved value (or restores the default Emacs value if you've never saved it), and "Erase" restores the standard value (what the Option would be if you started up an uncustomized Emacs). "Add Comment" let's you document your changes and saves a comment that will be displayed along with this value in future Customize sessions.

[233] Presented, somewhat annoyingly IMHO, in a "cleaned up" form, with hyphens replaced by spaces and all components capitalized.

[234] Either with the mouse or by moving Point to the button and hitting `RET`.

Customizing Multiple Options

While `customize-variable` and `customize-face` present one value at a time, most of the other Customize entry points let you view and change multiple values in one go. So each Customize Buffer has three extra buttons at the top:

```
Operate on all settings in this buffer:
 [Revert...]   [Apply]   [Apply and Save]
```

These buttons let you finish up multiple edits in one stroke: "Apply" will *set* all the Variables in this Buffer whose values you've changed; "Apply and Save" also saves them for future sessions; and "Revert" will undo any sets you've done.

Customizing a Face

Customizing a Face is much the same as customizing a Variable; it's mostly just a little more colorful.

Let's say you don't like the look of string literals in your favorite programming language. Just pull up a file, position Point on one of the offending strings, and say `M-x customize-face`. The prompt will look something like:

```
Customize face (default 'font-lock-string-face'):
```

(The default Face is that of the character where Point is.) Hit return and you'll be given a Customize form:

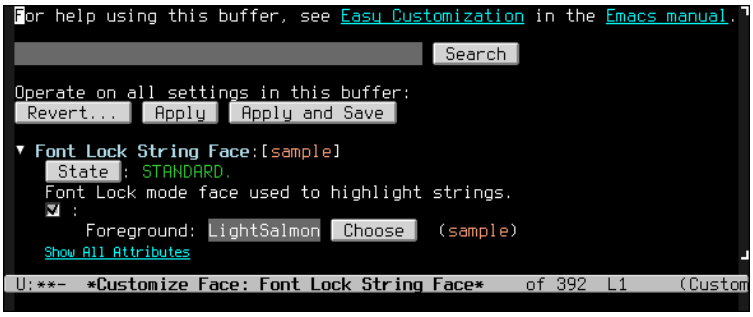


Figure 36: Customizing a Face.

(This Face only defines a "Foreground" color so the other attributes aren't shown; click `Show All Attributes` to change others.) If you click on the "Choose" button, the colorful `*Colors*` Buffer (see Figure 44) will pop up; browse it, and click the color you like (you can instead just type a color name[235] or RGB triplet `#RRGGBB` into the form where it says "LightSalmon"[236]).

Note that if you customize a Face this way starting from, say, a `python-mode` Buffer, it will affect all Modes and Buffers that use this

[235] You can't just make up a name; it needs to be a correctly spelled official color name for your OS, like say PapayaWhip.

[236] Mmmm... salmon...

exact, named, Face. A given Major Mode may define its own Faces, but `font-lock-string-face` is a standard Emacs Face and is used by many, perhaps most, Major Modes for syntax-highlighting string literals. The good news is, if you hate that Face in one Mode you probably hate it everywhere, so a sweeping change is appropriate! But if you only hate it for strings in `python-mode`, you'll have to get fancier to only change it there — I won't go into this here, but such is the power of Emacs that this is completely doable.

Customize Buffers Are Non-Modal

Like almost all of Emacs, Customize Buffers are not *modal*. That is, when you fire up a Customize Buffer, you don't have to commit to finishing the job *right now*. Take your time. The Buffer keeps track of your state. You can set one or more new values without saving them. This allows you to spend some time seeing how you like the changes you made. If you like them, you can just switch back to this Buffer later and then click "Apply and Save" (bound to `C-x C-s` in Customize Buffers). If you kill the Buffer after "Apply" but later (in the same session) reinvoke Customize with the same Variable or Face, you'll see that Emacs has remembered your changes, and you can now save them, revert them, or make further changes.

If you're really casual about your customizations, you might forget to save the ones you set for future sessions. I recommend this setting for your Init File, which causes Emacs to check with you when you exit—you'll be able to pull up a special Customize Buffer that contains all the values you've set but haven't yet saved, and you can take care of it.

Init File

```
(add-hook 'kill-emacs-query-functions
          'custom-prompt-customize-unsaved-options)
```

Long-Term Customization Management

There are some convenient commands for the long-term management of your customizations. `M-x customize-unsaved` (also known as `M-x customize-customized`) will pull up a Customize Buffer that pulls together all the customizations you've made in this session but haven't yet saved, which makes it easy to review, possibly change, and then save them all.

From an even longer-term perspective, `M-x customize-saved` will give you a Customize Buffer containing all the customizations you've *ever* saved, across all sessions; this is very handy if, after a month or so, you figure out you're unhappy with something you've changed,

and want to undo or tweak it.

While we're thinking in the long term... GNU Emacs has been around for 39 years already, and I'm confident that it will be around for many more years to come; there have been `1.34` new Emacs releases every year, on average. That means it won't be long before your OS package manager presents you with a fresh new Emacs in which some User Options will inevitably have been changed. `M-x customize-changed` (a.k.a `M-x customize-changed-options`) will present a Customize Buffer containing all these changed variables for you to consider.

Finally, if, like me, you've changed some User Options directly via Elisp in your Init File, `M-x customize-rogue` will let you see all of these in a Customize Buffer.

Where Are Customizations Saved?

The Customize Facility saves your customizations at the end of your Init File in two sections, one for User Options that looks like this:

```
(custom-set-variables
 ;; custom-set-variables was added by Custom.
 ;; If you edit it by hand, you could mess it up, so be careful.
 ;; Your init file should contain only one such instance.
 ;; If there is more than one, they won't work right.
 ...)
```

and one for Faces:

```
(custom-set-faces
 ;; custom-set-faces was added by Custom.
 ;; If you edit it by hand, you could mess it up, so be careful.
 ;; Your init file should contain only one such instance.
 ;; If there is more than one, they won't work right.
 ...)
```

As the warning indicates, you should avoid editing these special sections. If you notice something there that you want to fix, do it via `M-x customize-saved`.

It's also possible to tell Emacs to store these Customization sections in a different file entirely; this is only necessary if you're doing something fancy with your Init File, like generating it programmatically for example.

Customizing Key Bindings

The one thing the Customize Facility doesn't support is customizing your own key bindings; you have to do that in Elisp; see *Modifying*

Key Bindings.

The Package Manager

Emacs organizes most of its 21,669 commands and functions into 494 *libraries*: groups of functions related by purpose. When brand new functionality is added, as opposed to existing functionality being merely enhanced, the new code is organized as a new library; the libraries comprise 1,590 files of Emacs Lisp source code that are shipped together with Emacs.

Rather than Emacs just forever acquiring more and more new functions, and getting bigger and bigger all the time (which certainly still happens to some extent), this scheme allows major chunks of code that perhaps not everybody wants to use to be loaded into memory in a lazy fashion. If you're not going to be printing to a Postscript printer today, why bother loading the 226K `ps-print` library? This lazy approach is called *autoloading*; you'll see the word when looking at the documentation for commands and functions via the Help facility, as in:

```
ps-print-buffer is an autoloaded interactive Lisp function in ‘ps-print.el’.
```

Autoloading also speeds up start-up.

The next step up from library is *package*. A package is effectively a library—that is, Elisp source files—together with data files, Info documentation, and metadata (in the form of author information, a package description, a version number, and typically a list of *dependencies*: other packages that this package itself uses).

You can think of packages as *plug-ins*: software that adds new functionality to Emacs. You can install and uninstall them in real-time, as you use Emacs, without having to quit and restart.

Thanks to packages, third parties can write their own libraries and easily contribute them to collections of packages (called *repositories* or *repos*), and thanks to the metadata, these repositories are also searchable. The Free Software Foundation maintains two repositories of contributed packages (called GNU- and NonGNU-ELPA[237]), and there are two major community-maintained repositories (MELPA and Marmalade), and probably more that I don't know about.

[237] "ELPA" stands for Emacs Lisp Package Archive.

I recommend the GNU and NonGNU repositories, with 700 pack-

ages between them, and MELPA with 5,849, but I don't recommend Marmalade; it moves at a more aggressive pace and when I used to use it, packages could get updated several times a day and any one of those updates might be (briefly) buggy. But your mileage may vary!

Every package manager—for a programming language, the app store on your phone, or an application like a web browser—comes with security concerns, and Emacs is no different. Be sure to see *Security* for more information.

Configuration

Recent versions of Emacs come with the GNU and NonGNU ELPA repositories configured and ready to use. This Init File snippet adds the MELPA repo as well, and also assigns repo priorities that put a premium on stability (so, if a package appears in both the carefully curated GNU repo and in MELPA, we prefer the GNU version, all else being equal; you can change this if you prefer to live on the bleeding edge).

Note that the MELPA repo comes in two flavors: the stable repo and the unstable repo. I give the stable repo a higher priority than the unstable via the `package-archive-priorities` variable.

About Packages

How do you find out about these exciting additional packages? I mention several in this book, and you can find out about many more by following various Emacs mailing lists, blogs, and web forums. But mostly you find them by searching and browsing in Emacs.

If you've got the name of a package to hand, perhaps Vertico, you can read it's description via `C-h P` (`describe-package`). This will pop up a `*Help*` Buffer showing at least the package metadata, like this:

```
Package vertico is available.

     Status: Available from gnu -- Install
    Archive: gnu
    Version: 0.20
     Commit: 1bd5438da9c661e2df5e9516f36d9cbc6d100a34
    Summary: VERTical Interactive COmpletion
   Requires: emacs-27.1
   Homepage: https://github.com/minad/vertico
 Maintainer: Daniel Mendler <mail@daniel-mendler.de>
     Author: Daniel Mendler <mail@daniel-mendler.de>
```

The description may include extra text; the Vertico `*Help*` Buffer has 700-odd more lines of documentation.

Searching and Browsing

A quick way to find packages is via `C-h p` (`finder-by-keyword`), which pops up a Buffer containing a list of keywords—for example:

```
calendar      calendar and time management tools
languages     specialized modes for editing programming languages
mail          email reading and posting
matching      searching, matching, and sorting
```

However, this list is limited to built-in packages that come with Emacs, and those in the built-in repos.

Much better is to use `M-x list-packages`, which will download all the package descriptions from all the repos you have configured (four, in the Init File snippet above) and add them to the built-in packages. Here's a tiny excerpt from the thousands of entries in my `*Packages*` Buffer:

```
Package              Version       Status     Archive    Description

ace-jump-mode      2.0           available  melpa-stable  a quick cursor location minor mode for emacs
afternoon-theme    0.1           available  nongnu        Dark color theme with a deep blue background
vertico            0.20          available  gnu           VERTical Interactive COmpletion
org                9.4.4         built-in                 Export Framework for Org Mode
csv-mode           1.18          installed                Major mode for editing comma/char separated values
```

The `*Packages*` Buffer is called the *Package Menu*. Hitting `RET` on any of these lines pops up the same description that `C-h P` would present. You can sort the entries by clicking on the columns in the Header Line (typing `S` (`tabulated-list-sort`) will sort on the column containing Point), and of course use Incremental Search or Occur.

You can also filter the entries (rather like an in-Buffer Occur) by metadata keyword with `/ k` (`package-menu-filter-by-keyword`); `/ k calendar` is exactly like selecting `calendar` from `C-h p`, except it includes all the packages in the repos you configured. `/ n` (`package-menu-filter-by-name`) filters by package name, and `/ /` (`package-menu-clear-filter`) will restore all the entries.

The `*Packages*` Buffer is in fact your Emacs package manager, and you can do all your package maintenance in this Buffer; see *Package Maintenance* below.

Installing Packages

You can install a package by name, from any Buffer, with `M-x package-install`: the package will be downloaded if necessary, compiled, and loaded: it's now ready to use. Once installed, the package is available in future sessions (though some packages require enabling, typically done in your Init File, and configuration, typically done via Customize).

Installed packages live in your User Emacs Directory (see `user-emacs-directory`, typically `~/.emacs.d/`) in a subdirectory `elpa`.

You can also install packages directly from your Init File, like this:

```
(unless (package-installed-p 'vertico)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'vertico)))
(with-demoted-errors "%s" (vertico-mode +1))
```

This is a good way to make sure all the packages you like are installed in all your different Emacsen on your different computers, assuming you synchronize your Init File; if you only use Emacs on one computer, it's simpler just to install your packages manually (actually, that's all I do even though I use multiple Emacs installations: I'll quickly notice if a package is missing in some other installation as soon as I try to use it).

Probably the most common way to install packages is from within the Package Menu.

Package Maintenance

Package maintenance consists of installing new packages you want to use, deleting old ones you no longer use, and updating your packages to the latest versions. All of these tasks are typically done in the Package Menu. Table 31 lists the most useful maintenance key bindings; searching was described above, and navigation is similar to any other Special Mode Buffer.

Table 31: Package Menu Maintenance Commands

Key	Action
`RET`, `?`	describe the package
`i`	mark package for Installation (with an `I`)
`U`	mark all (installed) packages with Upgrades (with a `U`)
`d`	mark package for Deletion (with a `D`)
`~`	mark all obsolete packages for deletion (with a `D`)
`u`	Unmark this package
`x`	eXecute all marks
`g`, `r`	Refresh buffer from repo

The Package Menu works similarly to a Dired Buffer: you apply various *marks* to different packages (marks appear in the leftmost column), unmark any (with `u`) if you've changed your mind, and, when you're ready, *execute* all your marks with `x` (`package-menu-execute`). Any packages you've marked for installation will be down-

loaded, compiled, and activated, and those marked for deletion will be deleted (you can always reinstall them again at a future date).

You should periodically use the `U` (`package-menu-mark-upgrades`) command to check for packages that have new, upgraded, versions available. It will compare all the versions of your installed packages with the latest versions in the repos and mark any upgradable package with a `U`. (This can take a minute or so, depending on the repo, and so runs in the background.) When it's done, use `x` to upgrade the packages; after the new versions have been installed, it will offer to clean up obsolete versions for you.

As of v29.1, you can upgrade a package from outside the `*Packages*` Buffer with `M-x package-upgrade` and even upgrade all your packages with `M-x package-upgrade-all`.

Should You Write Your Own Packages?

Creating a proper Emacs package is easier than any other language I've used,[238] but it still involves a few additional steps (e.g. writing metadata) compared to just creating your own library (which just requires you to create a file of Elisp somewhere in your `load-path`). There's probably no need to go to the extra trouble of packaging if you're going to be the only user of your library.

But if you want to contribute your library to the Emacs community, then you'll need to package it; just follow the instructions in §41 of the Manual, *Preparing Lisp code for Distribution*.

[238] It's also extremely easy to set up a personal repository.

Updates and Bugs

Emacs Updates

I've mentioned before that there have been an average of `1.34` new Emacs releases every year in GNU Emacs's 39-year lifetime. That means it won't be long before your OS package manager presents you with a fresh new Emacs.

Emacs's backward compatibility is excellent, so it's unlikely that you'll experience any breakage when you fire up your new Emacs: your Init File will almost certainly still work perfectly, your key bindings will still be the same. At most, some things may look slightly different: changes in default fonts or colors for example, and you can always fix these if you're unhappy. You may see some *deprecation warnings* if you're using functions that are being phased out; the Emacs developers tend to give a *lot* of lead time for deprecated functions, so there's no need to panic.

However, it *is* likely that there will be new features that you will want to know about. `C-h C-n` (`view-emacs-news`) will display the *change log*, a very extensive list of all the user-visible changes in the version of Emacs that you're running: that is, everything that changed from the way it was in the previous version. If only you could get this kind of information for all the web services you depend on! If you invoke this command with a prefix argument, `C-u C-h C-n`, you can request the change log for any previous version of Emacs, all the way back to version `1.1` (the text of which is very quaint!).

After you've glanced at the change log for your new Emacs, you should run `M-x customize-changed` to see if there are changes to any of User Options that you've customized.

Emacs Bugs

What, does Emacs have bugs? Since all software does, I'm afraid so. One of the unique things about a Lisp Machine is that you can actually fix many bugs yourself, live, while your Emacs is running,

without recompiling or even restarting.

Assuming you're a programmer that is. If you're not, and you find a bug, you should report it. But first, you should try to make sure that this really is an Emacs bug, and not a problem stemming from some settings in your own Customizations or Init File. This means firing up a fresh Emacs with the `-Q` option, which avoids loading your init file and even some of the system-wide initialization, thus giving you a really pristine Emacs:

```
emacs -Q
```

Now try to replicate your bug. You may need to manually load a package that you `require` in your Init File if you think it's implicated in the bug; you can typically use `M-x load-library` to load it. The point is to have as few non-standard customizations and loads as possible.

The Manual contains an excellent chapter on reporting bugs, and you should really read it before reporting one: after all, you're having a problem with free software that you didn't have to pay for, and asking people to help you with your problem for free. You can at least try to make it as easy for them as possible.

If you can replicate your bug in this `-Q` environment, you can report it. Just say `M-x report-emacs-bug` and an email composition Buffer will pop up, with some instructions in another window. The email will be populated with up to several hundred lines of data about the current state of your Emacs: exactly which version you're running, how your Emacs was compiled, which packages you currently have loaded—all the kinds of information needed to help figure out your bug. (You can delete any personal info that you might be uncomfortable sharing.) You need to add a description of the bug, ideally including a step-by-step recipe showing how to make the bug happen. ("Put point at the beginning of the second word of a line with at least five words in it, and now. . . ")

If you've set up your Emacs to send mail, you can just use `C-c C-c` (`message-send-and-exit`) and your bug report will be emailed to the Emacs maintainers! (If you can't send mail from within Emacs, you can cut-and-paste the contents of the message into the mailer you use, as explained in the help window.) There's no guarantee that the Emacs maintainers can fix your bug, of course: they may not even be able to reproduce it, if it has something to do with your computer or operating system or the phase of the moon.

Not Emacs's Fault!

If you *can't* replicate your bug in this `-Q` environment, then it's probably not a bug in Emacs but in your Init File. You'll have to fix this

on your own. Generally the way you do this is to comment out all of your Init File except for the first line (really, the first complete s-expression, which might span several lines), save it, and fire up a fresh Emacs normally. Now see if your bug is fixed. If it is, you know the problem is *not* in that first line, but rather in the part of your Init File that you commented out!

But where? Well, now uncomment (i.e. restore) the *next* complete s-expression and repeat the process. Eventually you'll have restored the line that contains the bug and you'll know because suddenly the bug occurs again. Now just fix the offending line and restore the rest of your Init File, and you're done!

This process can be really tedious if you have a large Init File[239]. There are *much* more efficient ways to do this: really, any programmer would use binary search to find the bug, and there are tools in the Package Manager to do this automatically (see `bug-hunter`).

[239] Welcome to computer programming!

Helping Squash Bugs

If you're a programmer, you can volunteer to help fix Emacs bugs; all reported bugs are listed in the Emacs Bug Tracker. You can pick one out and see if you can fix it; see "Contributing" in the *Emacs* manual for more information. There's an excellent interface to the bug tracker in the Package Manager called `debbugs` that makes this even easier.

Exiting Emacs

All good things must come to an end, meaning you will occasionally have to exit your Emacs. As you know, the usual command to use is `C-x C-c` (`save-buffers-kill-terminal`). Note that if you are in an `emacsclient` instance, `C-x C-c` only terminates that client, leaving the server running. See *Client / Server* for details on how to terminate the Server.

If you have any modified Buffers (unsaved files) when you exit, Emacs will ask if you want to save these files before exiting with a prompt like:

```
Save file emacs-tutorial/emacs-tutorial.org? (y, n, !, ., q, C-r, C-f, d or C-h)
```

This prompt is really from the function `save-some-buffers` which `C-x C-c` calls. Your options for each file are summarized in Table 32.

Table 32: `C-x C-c` Modified File Prompt

Key	Action
`SPC`, `y`	save the prompted buffer
`!`	save all remaining unsaved buffers
`C-f`	switch to this File and stop exiting
`C-r`	peek at this buffer, Read-only
`d`	view a Diff of this buffer
`C-g`	cancel the whole exit command
`.`	save just the current buffer and exit
`DEL`, `n`	don't save the prompted buffer
`RET`, `q`	don't save this or any remaining buffers

The `C-r` and `d` responses allow you to peek at the file in question to figure out whether or not you want to save or abandon your modifications.

If, after this process, you still have modified Buffers because you answered `n` or `q` to one of the prompts, Emacs will ask:

```
Modified buffers exist; exit anyway? (yes or no)
```

(Emacs really wants to make sure you don't lose your data!)

Additionally, if you have any running subprocesses, you'll get a another cautious prompt:

```
Active processes exist; kill them and exit anyway? (yes or no)
```

Along with this you'll see a `*Process List*` Buffer showing all your subprocesses. The processes in question might be shells or terminals, or long-running commands you've fired up with `M-&`. Remember that if you kill Emacs, which is the parent of these subprocesses, the subprocesses will probably themselves die.[240]

[240] This is somewhat outside the control of Emacs, depending on your operating system and how the program running as a subprocess was written.

It's easy to type `C-x C-c` by accident, and who wants to terminate their long-running Server full of dozens of files? There's no problem if you have any modified file-visiting Buffers or subprocesses, thanks to the above prompts, but I personally never want Emacs to exit unless I'm about to reboot. So I have this snippet in my Init File:

```
(setq confirm-kill-emacs 'yes-or-no-p)        ; exiting emacs is silly
```

which causes Emacs to ask me still once more if I really mean it.

I highly recommend exiting Emacs explicitly when you terminate your login session (this of course includes rebooting or powering-off your computer). This assures that Emacs has a chance to save your files, and arrange for *persistence* if you're using the Desktop (see below). There's no need to exit Emacs when you sleep your computer, though if you're the cautious sort[241] you might do `C-x s` (`save-some-buffers`) before sleeping (I do).

[241] After all, batteries occasionally run down while your computer is asleep.

Occasionally, you might want to exit Emacs only to fire up a fresh one immediately. I don't do this very often, but occasionally in my Elisp hacking I might mess up the state of my Emacs, and rather than try to figure out exactly where I screwed up, I just want to start over. You can do this easily with `M-x restart-emacs`. The shutdown procedure I just described (saving buffers, killing processes...) is exactly the same, but then a new Emacs is immediately fired up for you, using the same command line options and arguments you originally used.

The Desktop: Persisting Your Buffers

You can easily have most of your file-visiting Buffers restored each time you start up a fresh Emacs by turning on `desktop-save-mode` and I recommend this for your Init File:

Init File

```
(desktop-save-mode +1)   ; restore files from previous session
```

Not only are your file Buffers restored: so is your location (Point) in each Buffer, its Major Mode, and even your Frames[242], their Window configurations, and all your Frame parameters (like fonts and font sizes).

[242] Your OS window manager is in charge of exactly where each restored Frame ends up on your screen; Emacs can only suggest locations for them.

`desktop-save-mode` also saves the Tabs in your Tab Bar, the contents of all your Registers, your EWW web Buffers, and probably

more (Emacs packages can readily hook themselves into `desktop-save-mode`).

By default, remote files loaded from other systems are excluded from being restored (in order to speed up restoration; also, the network or certain remote hosts might be unavailable when you restore). You can change this by Customizing `desktop-files-not-to-save`.

You can trash your saved Desktop configuration with `M-x desktop-clear`—you might want to do this if it's been such a long time since you last ran Emacs[243] that you're no longer interested in any of the files you were last editing and they're just clutter now. `desktop-clear` zaps the saved Desktop config and also kills all the Buffers that were initialized from that config.

[243] I suppose that happens...

`desktop-save-mode` definitely slows down your Emacs startup speed. Since I use the Emacs Server, and only fire up Emacs at most once every few weeks, I don't mind this at all. But you can Customize `desktop-restore-eager` in order to make the restoration of your Buffers happen *lazily*—that is, delayed in the background instead of all at once—which can give you a responsive fresh Emacs immediately.

By default, there's only one saved Desktop configuration, and you generally don't want another Emacs to use it: that will just cause conflicts! So the Desktop config is *locked* by the first Emacs that restores it, and any additional, newly fired-up Emacs will ask you if you really want to steal the lock:

```
Warning: desktop file appears to be in use by process with PID 1004.
Using it may cause conflicts if that process still runs.
Use desktop file anyway? (y or n)
```

The only good reason to say yes is if the locking Emacs crashed, and was unable to give up its lock, and isn't actually running anymore[244]. Note that there's no desktop conflict when using `emacsclient`, since it *connects to* the running Emacs and its desktop.

[244] The message tells you the PID so that you can check this.

If you want to fire up a nonce Emacs, perhaps just to test a change to your Init File[245], and don't intend to steal an existing desktop, just add the `--no-desktop` option; see *Starting Emacs!*.

[245] Always good practice: I do this all the time.

Starting Emacs!

Because I advocate using a long-running Emacs in Client / Server mode, I haven't talked much about the details of starting up a fresh new Emacs, which weirdly makes this chapter the last thing in Part I of the book.

Emacs has a number of command-line options to vary the details of how it starts up. Many of the options are very exotic and only useful to people doing really fancy stuff—for these, you can read the man page or see "Emacs Invocation" in the *Emacs* manual.

The rest of the options can be divided into two categories: those for scripting Emacs, and those for occasional everyday use. Most any option in that latter category that you find yourself using all the time can be better done in your Init File. Of course, my definition of these two categories is just rhetorical: there's no real division in use.

File Arguments

As usual for Unix programs, all command-line arguments that don't start with a hyphen are taken as the names of files to visit. So this command:

```
emacs file1 file2 file3
```

has the same effect as firing up Emacs with no arguments and then using `C-x C-f` (`find-file`) once for each file.

There's one exception: an argument of the form `+123` positions Point at line `123` of the first file named on the command line. The full form of this option is `+LN:CN` where *LN* is a line number and the optional *CN* is a column number.

This old-fashioned option is used by certain programs to fire up Emacs at the precise line where an error has occurred. `vi(1)` supports the same option, for example. In Emacs, we usually turn this inside-out by calling `M-x compile` from inside our running Emacs, and using `C-x ‘` (`next-error`) to load the files and jump to the error location; see *Compiling Code*. The `+` option might still occasionally be useful to an Emacs user via `emacsclient(1)`.

Occasional Options

Option	= Long Option	Action
`-d DISPLAY`	`--display=DISPLAY`	open Emacs on named X display
`-nw`	`--no-window-system`	open Emacs in this terminal
`-daemon`	`--daemon`	start the Emacs server
	`--version`	display version and exit
`-q`	`--no-init-file`	don't load user's init file
	`--no-desktop`	don't load saved desktop
	`--debug-init`	debug your init file
`-Q`	`--quick`	don't do *any* initialization

Table 33: Occasional Command-Line Options

Table 33 lists what I think are the most useful occasional options.

`-d` and `-nw` let you choose between running this Emacs in Graphical mode versus in a terminal. You'll recall that I'm an advocate of using Graphical mode. If you're running Emacs in a graphical environment (e.g., a Unix system running X windows, or under MS Windows or Mac OS), Emacs will default to Graphical mode; `-d` is mostly for X windows experts doing fancy things. If you're on a system that's not running in Graphical mode (like some big server machines, or in the console of your Unix desktop), you'll get Terminal mode by default and won't need `-nw`. `-nw` is mostly needed for those who are running a Graphical system but want to use Emacs in external terminals as if it were `vim(1)`.

The `-daemon` option is one of two ways of starting up the Emacs Server; see *Client / Server* for details.

The final group of options are mostly used for testing and debugging your Emacs configuration. `-q` runs an Emacs without loading your Init File or Customizations. It can be handy for a quick check of whether or not some recent Init File tweak you made has broken something: if the suspected breakage doesn't occur with `-q`, the problem has to be in your Init File. Since Desktop Save Mode has to be enabled in your Init File, `-q` implies `--no-desktop`, which tells Emacs not to load any saved Desktop; see *The Desktop*.

A certain happy category of bug that can occur in your Init File causes an explicit error each time you start Emacs. I call this a "happy" bug because it's the easiest kind of Init File bug to detect and fix! It can be hard to tell from the startup error where it is in your Init File, so just restart Emacs with `--debug-init` and Emacs will jump into the Elisp debugger when the error occurs, and you'll be able to tell exactly where the buggy code is.[246]

`-Q` is a more extreme version of `-q` that also doesn't load any system-wide init file or Elisp[247], nor any X window system resources. This is the option to use if you think you've found a bug in Emacs:

[246] Admittedly this may take a little familiarity with Elisp and the debugger.

[247] Such system-wide customizations probably don't exist on single-user machines.

replicating the suspected bug under `-Q` makes it very unlikely to be your fault; see *Updates and Bugs*.

Scripting Options

What does it mean to "script Emacs" when the whole idea of the Lisp Machine is to do everything inside Emacs with a real programming language, Emacs Lisp?

Well, sometimes we have to exist briefly in the world outside of Emacs, and use Emacs as if it were a tool like AWK or `sed(1)`; after all, Elisp is a much more powerful programming language than either of those. Additionally, you may want to automate some of your Emacs tasks via a build automation tool like `make(1)`; I do that to automate the building of this book; see the Colophon. Table 34 lists some of the options useful for this sort of thing. These options take effect in the order given, which can be significant. `-batch` puts Emacs into *batch mode*, which means it won't fire up any sort of interactive display: it will just process the remaining command line options, and then exit. It implies `-q` and is usually used with some combination of `-l`, `-f`, or `--eval`.

Table 34: Command-Line Options for Scripting

Option	Long Option	Action
`-batch`	`--batch`	run in batch mode
`-l FILE`	`--load=FILE`	Load an elisp file
`-L DIR`	`--directory=DIR`	add `DIR` to `load-path`
`-f FUNC`	`--funcall=FUNC`	call function named `FUNC` (with no parameters)
	`--eval=EXPR`	evaluate elisp expression
	`--script FILE`	run Elisp from FILE in batch mode
	`--kill`	exit Emacs unconditionally

The `--eval` option evaluates an arbitrary Elisp expression. This example is a homemade variation on the `--version` option:

```
emacs -batch --eval '(message "%s" (emacs-version))'
```

Most Emacs functions aren't designed for command-line use, though: they use Buffers rather than simply printing text to the standard output. But it's easy to write Elisp functions suitable for the command-line: you might collect some in a file that you can load with `-l` and then invoke a function in it with `-f`. But if you're going this far, you might as well write a proper Elisp script, for which the `--script` option is handy. Here's a dumb Emacs script that counts words in the files named on the command line:

```
#!/usr/bin/emacs --script
(dolist (file argv)
  (with-temp-buffer
    (insert-file-contents file)
    (message "%s: %s words" file (count-words (point-min) (point-max)))))
```

Part II

ADDITIONAL TOPICS

Completion at Point

Up to now, when we've talked about completion we've been talking about it in the Minibuffer. But we can also do completion in any buffer, at Point. This might be familiar from the way IDEs complete keywords and symbols for various programming languages, and Emacs Major Modes for programming languages do this too; see *Pop-up Menu Completion*. But Emacs also does this for ordinary text in any buffer, and it's an amazing feature, called *dynamic abbreviation expansion* or *Dabbrev* for short[248].

[248] This feature dates back to at least 1998.

Dynamic Abbrevs

As you begin typing a longish word that you know or just suspect you've typed before, hit `M-/` (`dabbrev-expand`) after the first few characters and the word will complete (or expand) in place. For example, I just typed "char" and `M-/` expanded it to *characters* — exactly what I wanted.

If that *wasn't* the word I wanted, I would just have immediately hit `M-/` again, and it would have changed the completion to another word starting with "char": in my case, one of *character*, *charts*, or *charlie*. Why? Because those are all the words that start with "char" that I've used in this book. More `M-/`'s would cycle through all the words that match; I just stop when I get to the one I want.

The completion candidates are selected from the preceding words in the buffer, sorted so that the first one offered is the *nearest preceding matching* word; the next would be the second-nearest, and so on.

If I keep cycling after rejecting the match that's closest to the beginning of the buffer, or if there's no matching preceding word at all, then candidates will be offered that are *ahead* of me in the buffer (again in the order of closest to farthest).

Suppose my buffer contains just this one line; I've just typed "com" and Point is indicated by `|`:

```
completely completeness completer com| completes completest completing completion
```

What is the sequence of completions offered up by a repeated series

of M-/'s?

The first completion offered is *completer*, followed by *completeness* and *completely*. We've hit the beginning of the buffer, so the next M-/ would offer *completes* followed by *completest*, *completing*, and *completion*.

What happens if, having rejected the last match in the buffer, we hit yet another M-/? Aha! In that case, M-/ proceeds to look for matches in *other buffers*! This almost makes it seem like M-/ can read your mind, and the effect and usefulness of this increases the more buffers you have.

By default, M-/ will only examine other buffers that have the same Major Mode, so that if you're editing poetry in latex-mode, say, it won't offer you the names of variables and functions from your buffers full of Elisp code. But if these same-mode buffers don't have *any* candidates, it will then consider all types of buffers.

You can fine-tune this to make it behave exactly the way you like via M-x customize-group RET dabbrev; see "Dynamic" in the *Emacs* manual.

The tricky part of Dabbrevs is, how many characters do you type before hitting M-/? If you type too few, you could get so many candidates that it might take you ten times as long to cycle to the one you want as it would to just retype the word. But even one character could be okay if the word you want is long and you just typed it a line or so ago. If you don't seem to be getting what you want after a few tries, just Undo and either type the whole thing, or try C-M-/ (see *Dabbrevs via Menu*).

Once you get used to M-/, you'll develop a sort of automatic ability to know when to use it, and it will both dramatically speed up your typing, and reduce the number of typos you enter.

You can also complete a sequence of words. Suppose you're writing about your favorite Czech composer[249] and need to type his name again. You type "Le" and then M-/ completes "Leoš"; now immediately type SPC M-/ and his last name, "Janáček" appears (this is assuming that you have his full name, "Leoš Janáček", somewhere in your Emacs). You can keep typing SPC M-/ to add more words: in general, you can complete an n-word sequence, possibly containing some very long words, in about $n \times 2$ keystrokes via a long sequence of SPC M-/'s, though frankly I've probably never used this technique for more than two or three words.

[249] Actually, my favorite Czech composer is Erwin Schulhoff.

Dabbrevs via Menu

There's another command to do completion at Point sort of indirectly, via your preferred completion framework. (I would say this is not

worth using unless you've set up an INF like Vertico or Ivy, or are happy using the mouse.)

Type a partial word but this time invoke `C-M-/` (`dabbrev-completion`). Instead of instant completion at Point with the first candidate, and the need to cycle through them, you'll be presented with a complete list of candidates using whatever interface your INF uses (Ivy will use a pop-up menu, Vertico the Minibuffer).

I don't use this as often as `M-/` but it's sometimes handy.

Hippie Expand

If Dabbrev isn't fancy enough for you, you can use *Hippie Expand*. Hippie works exactly like `M-/` (`dabbrev-expand`), except it chooses from a much wider range of sources of candidates. One of the sources is simply `dabbrev-expand` itself, but it can also expand file-names, entire lines, parenthesized lists, kills from the kill ring, etc. You can customize which sources you want to use and in what order. Most people that use Hippie just bind it to `M-/` in place of `dabbrev-expand`, but you can use a different binding in order to have access to both. (The one thing Hippie can't do is expand sequences of words the way Dabbrev can.)

The only problem with Hippie Expand is that there are so many candidates it can offer, what you get can seem like a crap shoot. Really, I think it would be more useful if it offered completions the way `dabbrev-completion` does (implementing that would be a fun project).

But it's quite amazing, and I bind it to `M-/` to replace `dabbrev-expand`; try it and see what you think!

Pop-up Menu Completion

There's also *pop-up menu completion*. This form of completion-at-Point is primarily for completing *symbols*—e.g., the names of variables, functions, and the like—in programming language modes, though it's more general than that. There are two main frameworks to choose from, and either needs to be installed from the Package Manager: Company and Corfu.[250] Candidates for completion can come from many sources, some built-in and most from optional back-ends, so that besides symbols for a programming language, you can complete email addresses, dictionary words, and Unicode math symbols and emojis by name, among others.

Corfu is modern, clean, and "standards compliant", meaning it uses the official Emacs APIs to get its completion candidates, whereas Company instead uses its own backends—but then, there are 75 of

[250] There's also the older `auto-complete` framework, which has 45 backends, but `auto-complete` is old and buggy, and I can't recommend it.

them in the Package Manager. One disadvantage of Corfu is that it only works in a graphical-mode Emacs.

Both work roughly the same way: as you type the name of a symbol, a menu of completions pops up at Point, either automatically or upon a keystoke, as you prefer; you scroll to the completion you want (with `TAB` or some other key), and hit `RET` to accept and expand it at Point. For some symbols, a one-line description will appear in the Minibuffer. You can see from Figure 37 and Figure 38 that they look similar: here I'm in Emacs Lisp Mode and have started typing the name of function: at the point at which I'd typed "with-s" and paused for a fraction of a second, I get the menu.

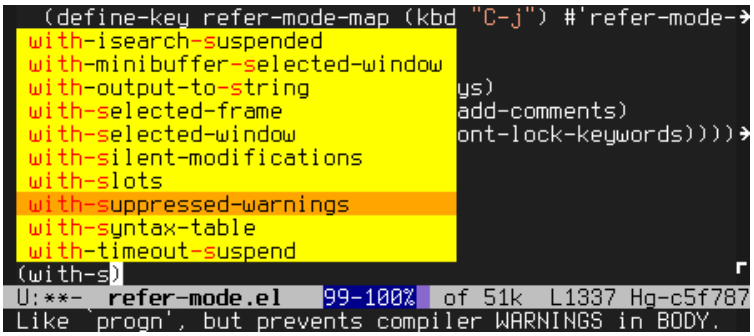


Figure 37: `company-mode` in an Emacs Lisp buffer

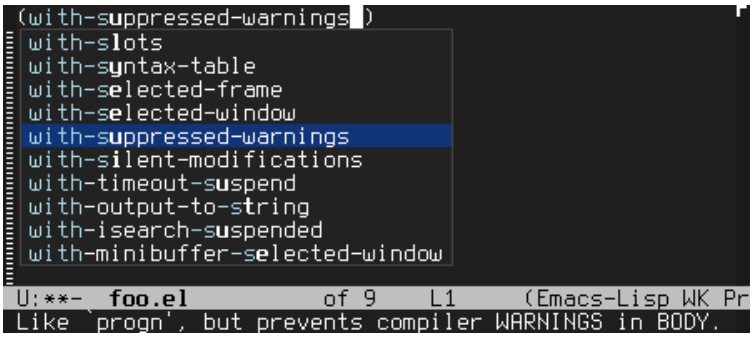


Figure 38: `corfu-mode` in an Emacs Lisp buffer

In my opinion, popup-menu completion doesn't really do too much for you that Minibuffer completion doesn't—except for automatically insinuating itself as you type, if you choose that mode of activation—assuming you're using a good Incremental Narrowing Framework, but your mileage may vary. Without popup completion, you can just invoke `M-TAB` (`complete-symbol`) (which is the same as `C-M-i`) and complete the symbol in the Minibuffer; see Figure 39.

Since you get to use all the narrowing features of your preferred Minibuffer completion framework, I prefer plain old `complete-symbol` to popup completion.

If you want to try popup completion, I guess I would recommend Company; just add this snippet to your Init File:

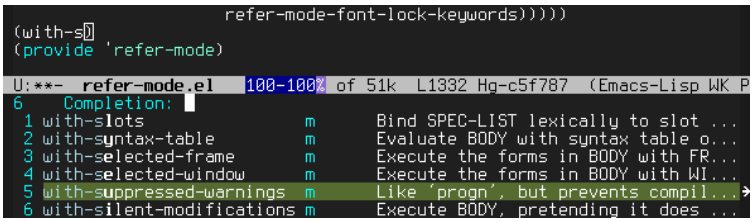


Figure 39: `complete-symbol` in an Emacs Lisp buffer

```
(unless (package-installed-p 'company)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'company)))
(add-hook 'prog-mode-hook (lambda () (with-demoted-errors "%s" (company-mode))))
```

Registers

When you're working in Emacs, you might save a lengthy chunk of text in the Kill Ring so that you can yank it back in several different places with a simple `C-y` (`yank`). The Kill Ring can hold many distinct chunks, but they're all *anonymous* and get pushed deeper into the Ring with each new thing you kill (and if you kill enough text, the oldest items will disappear from the Kill Ring). It would be nice to be able to give certain chunks of text names so that you can easily remember how to access each of them.

Almost every programming language has the notion of a named *variable* that you can set to some value for convenient reuse, and you could use Emacs Lisp variables for this purpose, but Elisp is verbose and you need to understand the subtleties of the language to use it.

So Emacs offers *Registers*: special purpose named variables that can hold not just text, but a variety of things that you might want to hang on to and eventually get back. The name of a Register is limited to a single character: any ASCII character except for `*` or `C-d` (which have a special interpretation). Most people stick to letters (Register `a` is different from Register `A`) and digits. (See below for naming tips.)

For each type of thing you can store, there's a command to *set* the content of the Register, and a command to *get* the content. There are only two getters: `C-x r i` (`insert-register`) serves for Register types whose content gets *inserted* in a Buffer, and `C-x r j` (`jump-to-register`) serves for those types that hold something that you in some sense *jump* to.

Type	Set	Get	Contents
Text	`C-x r s`	`C-x r i`	an arbitrary blob of text
Number	`C-x r n`	`C-x r i`	a number
Rectangle	`C-x r r`	`C-x r i`	a rectangle
Position	`C-x r SPC`	`C-x r j`	location of Point in this Buffer
Window Config	`C-x r w`	`C-x r j`	Windows layout of the current Frame
Frame Config	`C-x r f`	`C-x r j`	the layout of all your Frames
Keyboard Macro	`C-x C-k x`	`C-x r j`	the most recent Keyboard Macro

Table 35: Register Commands and Types

Register Preview and Contents

Whenever a Register command prompts you for a Register name, it displays a transient Buffer that contains a preview of the contents of all defined Registers, as an *aide memoire*. You can see this preview[251] at any time with `M-x list-registers`. Because a Register can contain a huge amount of text, the content can be truncated in these previews. If you want to see the entirety of the value in a Register, use `M-x view-register`.

[251] In a non-transient Buffer.

Registers are global data structures (not Buffer Local), so that they can be used to move things from one Buffer to another.

Text in Registers

The *set* command for text is `C-x r s` (`copy-to-register`) or its alias `C-x r x`. It prompts you for a Register name and then stores the text between Point and Mark (i.e., the Region) in that Register. With a prefix argument, it deletes the text from the Buffer after storing it (you can think of this as *moving* the text from the Buffer into the Register).

The *get* command for text is `C-x r i` (`insert-register`) or its alias `C-x r g`; it inserts the value into the Buffer at Point.

You can append or prepend text to a Register with `M-x append-to-register` and `M-x prepend-to-register`; see "Text Registers" in the *Emacs* manual.

Numbers in Registers

There is a special *set* command for numbers because you can use a proper number in a Register as a counter; `C-x r +` (`increment-register`) will add 1 to the current value of the Register (or some other increment, if given as a prefix argument). This can be useful for Keyboard Macros in which you need to count more than the one thing that the built-in Macro Counter can count.

Rectangles in Registers

`C-x r r` (`copy-rectangle-to-register`) saves a *rectangle* to a Register, and `C-x r g` inserts it into a Buffer. See *Rectangles* for details.

Buffer Positions in Registers

You can store the position of Point in the current Buffer in a Register, with `C-x r SPC` (`point-to-register`), which has the aliases

`C-x r C-SPC` and `C-x r C-@`. The *get* command for positions is `C-x r j` (`jump-to-register`), which takes you directly to that saved location. The Buffer itself is recorded along with your position, so you can jump from one Buffer to another.

File- and Buffer Names in Registers

You can also store a filename in a register, in which case `C-x r j` will actually do a `find-file` for you (if the file is already in your Emacs, it will jump to its Buffer). But strangely, there's no *set* command to store a filename in a Register[252]: the Manual says to use Elisp. As of v29.1, you can now jump to a Buffer named in a register, but just as with filenames, there's no command to store one, though again it's easy to write one.

So I've defined the missing function; I put it on `C-x r C-f`.

[252] You can store a filename as a string with `C-x r s` but that counts as text to be inserted later, not as a filename to be loaded.

```
(defun kw-filename-to-register (filename register)
  "Store a filename in a register.
Interactively, if a prefix arg, prompt for FILENAME.  With no
prefix arg, use `ffap-file-at-point' to get the filename at point; if
that fails, use the buffer file name; if there is none, prompt for the
filename.  Reads the REGISTER using ‘register-read-with-preview’."
  (interactive
   (let ((filename
          (if current-prefix-arg
              (read-file-name "Filename: ")
            (or
             (progn
               (require 'ffap)
               (ffap-file-at-point))
             (buffer-file-name)
             (read-file-name "Filename: ")))))
     (list
      filename
      (register-read-with-preview
       (format "Filename %s to register: " filename)))))
  (set-register register `(file . ,filename)))

(keymap-global-set "C-x r C-f" 'kw-filename-to-register)
```

But if the idea of giving short names to a variety of files that you visit frequently seems appealing, you should probably check out Bookmarks instead.

Window and Frame Configurations in Registers

As discussed in *Window Configurations*, `C-x r w` (`window-configuration-to-register`) will store your current Frame's Window Configuration in a Register, and `C-x r f` (`frameset-to-register`) will save your Frame Configuration (i.e., all your Windows in all your Frames). In both cases, `C-x r j` will restore it.

Keyboard Macros in Registers

You can save the most recently defined Keyboard Macro in a Register with `C-x C-k x` (`kmacro-to-register`) and invoke it with `C-x r j`. Why would you do this when you can assign Macros to keys in the `C-x C-k` keymap with `C-x C-k b` (`kmacro-bind-to-key`)? The main advantage is that `desktop-save-mode` will save any Macros in Registers for future Emacs sessions without any extra work on your part, while preserving `C-x C-k b` bindings requires the extra steps described in *Naming and Binding Your Macros*.

Saving Your Registers

You can automatically save the contents of all your Registers for future sessions with the highly recommended Desktop Save Mode.

I have many Registers that have each retained their contents for years and I use them regularly; they all have mnemonic alphabetic names. But I regularly also need transient Registers that I definitely don't care about maintaining forever. I need short-term mnemonic names but don't want to accidentally clobber one of my "permanent" Registers. What to do?

My solution is to use control characters for the names. So for example, Register `k` contains:

```
call_kb(key="",cmd="")
```

(a snippet of Org Mode code that I've used in this book hundreds of times), so when I temporarily need a Register to hold a blob of text about, say, koalas, I might use `C-k` as the Register name.

Rectangles

Programmers and system administrators often need to edit files of rigidly structured text, organized at least partially into columns. It can be very useful to be able to add, delete, or modify a rectangular chunk of such text, and indeed Emacs has a suite of commands to do so. But how do you indicate such a chunk?

A *Rectangle* is just a special interpretation of the usual Region. Normally, the Region is the linear sequence of characters (counting newlines as ordinary characters) between Point and Mark, as in Figure 40.

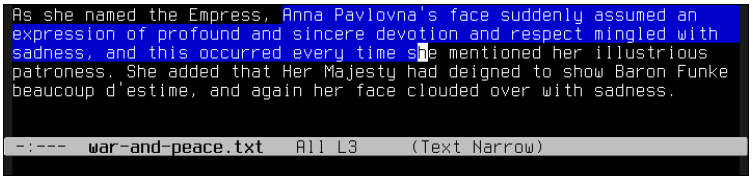


Figure 40: A Linear Region

But the Rectangle commands interpret the exact same Region rectangularly, as in Figure 41.

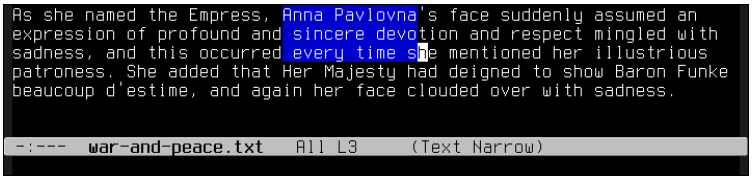


Figure 41: A Rectangular Region

Once we've defined a Rectangle we can easily do things to it, like say blank it out with one keystroke (Figure 42).

Figure 42: A Rectangular Region, Blanked

To work with a Rectangular Region, just set the Mark at any of the four potential corners of the Rectangle, then move Point to the

diagonally opposite corner. At this moment, the ordinary linear Region has been defined and will look (if you activate it with the usual `C-x C-x` (`exchange-point-and-mark`)) like Figure 40. To switch the interpretation to rectangular, do `C-x SPC` (`rectangle-mark-mode`), and you'll see something like Figure 41. (Alternatively, you can sweep out the Rectangular Region with `C-M-mouse-1` (`mouse-drag-region-rectangle`).)

With the Rectangular Region activated, Point is fixed to one of the four corners. You can grow or shrink the Rectangle in any of the four cardinal directions with ordinary motion commands (such as `C-f` (`forward-char`), `M-b` (`backward-word`), `<down>` (`next-line`), or whatever). Whether the Rectangle grows or shrinks depends on the direction of the motion relative to the location of Point.

You can cycle Point around the corners with repeated invocations of `C-x C-x`, which, when the Rectangular Region is activated, is `rectangle-exchange-point-and-mark`. If Point is at the upper- or lower-right corner, rightward motion will grow the Rectangle to the right, and leftward motion will shrink it to the left, for example.

In addition to the motion commands, commands that kill or copy the Region, like `C-w` (`kill-region`) and `M-w` (`kill-ring-save`), will operate on the Rectangle, and so will commands that modify the text in the Region, like `C-x C-u` (`upcase-region`).

To deactivate the Rectangular Region, just use `C-g` (`keyboard-quit`).

Inactive Rectangular Regions

The motion and Region-manipulating commands described above only have their special Rectangular interpretation when the Rectangular Region is *activated*. But as you know, if the Mark is set in your Buffer, there is a Region present, even it isn't activated. The same is true of the Rectangular Region: if there's a Mark, there's an implied Rectangle, and there is a set of explicit Rectangle commands (see Table 36) that will operate on it whether you activate it with `C-x SPC` or not (you might prefer to activate it just so the precise extent of your Rectangle is more obvious).

`C-x r c` changes every character in the Rectangle to a space, "clearing" it (as in Figure 42). `C-x r o` on the other hand opens up a new rectangular space where you've marked your Rectangle, but preserves the original text of the Rectangle by shifting it to the right (that includes all the text to the right of the original Rectangle too).

Deleting or killing the Rectangle actually eliminates all the characters contained in the Rectangle, rather than converting them to spaces as `C-x r c` does, thus squashing the Rectangle out of existence

Table 36: Explicit Rectangle Commands

Key	Action
`C-x r c`	Clear rectangle (overwrite with spaces)
`C-x r d`	Delete rectangle
`C-x r k`	Kill rectangle
`C-x r y`	Yank previously killed rectangle
`C-x r o`	Open rectangle (shift rectangle right)
`C-x r t`	replace Text of rectangle
`C-x r N`	Number rectangle's lines
`C-x r r`	copy rectangle to Register

and shifting all the text to right of it leftward. If you use `C-x r d` (`delete-rectangle`), the text of the Rectangle is gone forever[253], but if you use `C-x r k` (`kill-rectangle`) you can later yank the Rectangle back with `C-x r y` (`yank-rectangle`).

[253] Unless of course you Undo...

`C-x r t` is probably the Rectangle command I use the most: it replaces the text of the Rectangle with new text: you're prompted for a new single line of text, and that line replaces the text of each of the Rectangle's lines. Consider this list of some of my favorite drummers:

```
+ Chris Cutler
+ Max Roach
+ Tatsuya Yoshida
+ Christian Vander
```

I can change all the plus signs to bullets by setting a one-character-wide Rectangle containing the column of pluses, and then executing `C-x r t •`.[254] The result will be:

[254] How do you type that bullet character? See *International Character Set Support*.

```
• Chris Cutler
• Max Roach
• Tatsuya Yoshida
• Christian Vander
```

The new text doesn't have to be the exact same width as the Rectangle; if instead I used the string "Drummer" the result would be:

```
Drummer Chris Cutler
Drummer Max Roach
Drummer Tatsuya Yoshida
Drummer Christian Vander
```

Old- and New-School Rectangle Commands

The commands in Table 37 were necessary before the invention of the Rectangular Region in 2014, and of course you can still use them, but if you're activating the Rectangular Region via `C-x SPC` you can use the easier commands discussed above.

Key	Inactive Rectangular Region (Old School)	*Active* Rectangular Region (New School)
`C-x r k`	Kill rectangle	`C-w`
`C-x r d`	Delete rectangle (not yankable)	`C-w` (yankable)
`C-x r M-w`	copy rectangle to Kill Ring	`M-w`
`C-x r y`	Yank rectangle	`C-y`

Table 37: Old- and New-School Rectangle Commands

Empty Rectangles

If you set the Mark, and then move point directly downward say four lines with `C-n` (`next-line`), you have created an *empty Rectangle* with a width of zero columns which is four lines in height. Such empty Rectangles are very useful! If you've typed in my list of drummers without any kind of bullet:

```
Chris Cutler
Max Roach
Tatsuya Yoshida
Christian Vander
```

then you can add the bullets by defining an empty Rectangle extending vertically from in front of the "C" of Chris Cutler down to the "C" of Christian Vander, and then using `C-x r t` to insert the bullets.

Yanking Rectangles is Subtle

When you yank back a previously killed Rectangle with `C-x r y` (`yank-rectangle`), the lines of the Rectangle are inserted into the Buffer with Point being the upper-left-hand corner of the inserted text.

If I have previously killed a 3-line Rectangle consisting of hyphens, and I position Point right before the space in the first line of this block of text:

```
XXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

and then I say `C-x r y` (`yank-rectangle`), the result might look like this:

```
XXXXXXXX----- XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXX-----XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXX-----XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Note how yanking shoves the characters to the right, rather than replacing any of them. To instead achieve *this* result:

```
        -----
        -----
        -----
XXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

you would need to first, before yanking, open up three blank lines (perhaps with `C-u 3 C-o` (`open-line`)) and insert eight spaces on the first of them to position Point where you want it horizontally.

`C-o` is very handy when yanking Rectangles. Rather than counting precisely, you can often give it a big numeric argument to open more lines than you'd need, say, with `C-u C-u C-o` to get sixteen blank lines, yank your Rectangle, and then close up the extraneous blank lines with a couple of `C-x C-o` (`delete-blank-lines`)'s.

Bookmarks

Emacs Bookmarks are a sort of generalization of Filename Registers, but they come with long names, some additional commands, and a Major Mode for browsing and maintenance. Most of us have a set of files, located all over the file system, that we visit on a regular basis: Bookmarks are the way to manage them, and they automatically persist across Emacs sessions[255].

[255] Even without enabling the Desktop.

Bookmarks were probably originally designed as a way to save your position in a file, just like a physical bookmark does in a physical book: they let you open up a file at the exact point that you were last reading (or editing).

But for this aspect of Bookmarks, `save-place-mode` works better. If you enable it in your Init File (and I recommend you do), every time you open any file, Point will be set to the position it had when you last saved the file.

Init File

```
(save-place-mode +1)   ; come back to where we were in that file
```

The main Bookmark commands share the `C-x r` prefix with the Register and Rectangle commands. and basic usage is quite straightforward:

Table 38: Bookmark Commands

Key	Action
`C-x r m`	set or update a bookMark *NAME* here
`C-x r M`	set a *new* bookMark *NAME*
`C-x r b`	jump to Bookmark *NAME*
`C-x r l`	pop up List of all bookmarks
`M-x bookmark-insert`	insert contents of bookmarked file
`M-x bookmark-insert-location`	insert filename of bookmarked file

When you set a Bookmark with `C-x r m` you'll be prompted for a name, which is an arbitrary string (not just a single character like a Register); typing `C-w`'s at the prompt will slurp up words from Point to use as the name. The default name will be the Buffer's filename[256]. You can only bookmark files or directories (`C-x r m` will work in a Dired Buffer), so you'll get an error if you're in a Buffer that's not visiting a file. Note that you *can* bookmark remote Tramp files and

[256] Or its Bookmark name, if you've already bookmarked this file with a name that's distinct from the filename.

directories: extremely useful, and there's special support for bookmarking chapters of Info documentation.

Each Bookmark records not only the file, but the current location of Point. You can have several Bookmarks pointing to different locations in the same file, but you'll want to give them distinct names so you can keep them straight.

If you have a Bookmark, and you invoke `C-x r m` at a different location in the same file, Emacs will update the Bookmark to reflect the new location of Point. With a prefix arg `C-u C-x r m` will update the Bookmark but rather than discarding the old location, will *shadow* it: when you delete the Bookmark, the previous location will be restored. Effectively, with `C-u` you can push any number of new locations on a stack and pop them off later.[257]

[257] I've never used this feature; I think it would be more useful with a better user interface in the Bookmarks menu.

I say that a Bookmark records the value of Point, but actually it also stores some of the file's text before and after Point, so that if the file changes slightly, Emacs can restore your location with more accuracy.

`C-x r M` is just like its lowercase sibling, except that it will refuse to update an existing Bookmark.

Jumping to a Bookmark is as easy as `C-x r b`: just type the name and go. With a good Completion enhancement like Marginalia you'll get some useful extra context.

With `M-x bookmark-insert`, you can also insert the complete contents of a Bookmarked file into the current Buffer at Point; this is like `C-x i` (`insert-file`) except you use the Bookmark name rather than the complete filename. `M-x bookmark-insert-location` inserts just the filename of the named Bookmark.

Bookmark Maintenance with the Bookmark Menu

`C-x r l` (`bookmark-bmenu-list`) pops up the Bookmark Menu Buffer, a two-column listing of all your Bookmarks; it might look something like this:

```
% Bookmark     File
  Inbox.org    ~/notes/syncthing/Inbox.org
  Web Space    /ssh:example.com:/home/login/web
  backdrops    ~/images/backdrops/DB
  books        ~/books/2022.db
```

This Buffer works much like Dired or Buffer Menu, so you can probably start using it without any explanation: hit `RET` on a line to jump to that Bookmark, `d` to flag a Bookmark for deletion, and `x` to execute your deletions.[258] Here's a subset of the truly Bookmark-specific commands; as always, you can use `C-h m` (`describe-mode`) to see

[258] I guess I just explained it there, didn't I?

the expected Special Mode commands for scrolling, opening your Bookmarks in the usual Window and Frame variants, marking lines to open several in one go, limiting to matching Bookmark names, and the like.

Table 39: Bookmark Menu Commands

Key	Action
`r`	Rename this bookmark (same file, new name)
`R`	Relocate this bookmark (same name, new file)
`k`	Kill this bookmark immediately
`d`	flag (with `D`) this bookmark to be Deleted
`x`	eXecute deletions of bookmarks marked with `d`
`a`	show the Annotation
`A`	show All annotations
`e`	Edit the annotation

Bookmark Annotations

Bookmarks can have simple *annotations* attached to them; Bookmarks with annotations are marked with an asterisk (`*`) at the left. From the Bookmark Menu, use the `a` command to display this line's annotation in a pop-up Window (`A` will show all of them). To add or edit an annotation, use the `e` command.

Since a Bookmark is specific to a particular location in a file, you could theoretically annotate many lines by creating many Bookmarks, but practically speaking, the Bookmark Menu interface isn't really up to this task. There are third-party packages that handle this properly.

Abbreviations

Most forms of completion are about making it easy for you to choose from a set of candidates, but Emacs also has a system known as *Abbrevs* in which a short, user-defined abbreviation, at the moment you type it, automatically expands to something (usually) much longer.

The great thing about Abbrevs is that they happen instantaneously without your having to type so much as a single extra keystroke to invoke a completion command: they just magically expand as you're typing! Suppose you're writing about Transylvanian cuisine and find yourself typing "Székelykáposzta" a lot. You might like the Abbrev "sk" to expand to that word, properly capitalized, so that when you type "Cooking sk is easy", the Abbrev expands right after you type "sk", the result being "Cooking Székelykáposzta is easy".

Of course there's a flip-side. Unlike completion patterns, you have to *define* the Abbrevs you want to use, and, since they expand magically, they might occasionally expand when you don't want them to.

Let's try it. First, in some writable Buffer, you need to enable the Minor Mode `abbrev-mode` with `M-x abbrev-mode`. This is a Buffer Local Minor Mode, so it will only apply to the current Buffer.

Next, you have to define yourself an Abbrev. You might decide to do this after you've typed some long or tricky-to-spell word enough times that you notice you're sick of doing it, so the expansion is right there in the buffer, to the left of Point. Before typing any further, give the expansion an abbreviation with `C-x a l` (`add-mode-abbrev`). This command defines an Abbrev for the word immediately before Point. It prompts for the abbreviation:

```
Mode abbrev for "Székelykáposzta": sk
```

That's it! Now "sk" will expand to Székelykáposzta in this Buffer.

Actually, as the name `add-mode-abbrev` suggests, it will expand in all buffers that are in the same Major Mode and in which you've turned on `abbrev-mode`. If this buffer is in Org Mode, then "sk" is "Székelykáposzta" in all your Org Mode buffers, until you either

change your mind and undefine it or until you end your Emacs session.[259]

[259] But see below for saving your Abbrevs across sessions.

You can also define *global* abbrevs that work everywhere `abbrev-mode` is enabled, regardless of the Major Mode, with `C-x a g` (`add-global-abbrev`).

The mnemonics for these keystrokes, then, are:

`C-x a l` Abbrev, Local (to Mode)

`C-x a g` Abbrev, Global

Both `C-x a l` and `C-x a g` take, as the expansion text, the text from Point backwards to the beginning of the previous word. This means that if you type the expansion "foo "—note the space after the word and before Point—the expansion will include the space, and also any trailing punctuation; this will be clear from the prompt. For maximum flexibility you typically don't want trailing spaces or punctuation in your expansion text.

Multi-Word Expansions

What do you do if you want your expansion text to include multiple words? I might want an Abbrev for the name of my workplace, The University of Chicago, for example. With Point after Chicago, I can use a numeric argument of 4 like so: `C-u 4 C-x a l`. I could also put the Region around the expansion text and use a numeric argument of zero: `C-u 0 C-x a l`[260] These numeric arguments work identically for the global command `C-x a g`.

[260] The Active Region isn't supported, I suspect because the Abbrev commands long predate it.

You can also define Abbrevs the other way around, by typing the Abbrev in the buffer and then using either `C-x a i l` (`inverse-add-mode-abbrev`) or `C-x a i g` (`inverse-add-global-abbrev`). This way you never have to count the words in your expansion.

All these defining keystrokes seem to be designed for people who are constantly adding Abbrevs on the fly as they type at speed, but for me this only happens very occasionally. So I think the easiest way to define an Abbrev is with `M-x define-mode-abbrev` and `M-x define-global-abbrev`. These commands prompt you for both the expansion and the abbreviation in the Minibuffer, so there's no counting or Region-setting.

Abbrevs and Case

The case of the letters you use in typing an Abbrev control the case of the letters in the expansion in a manner analogous to the way case works in Isearch. If you've defined "wa" as an abbreviation

for "wallabies", typing "Wa" instead of just "wa" will expand to "Wallabies" and "WA" will expand to "WALLABIES".

Unexpanding Unhappy Expansions

What do you do if an Abbrev expands when you don't want it to? First, you should choose unlikely abbreviations to minimize this problem: if you write primarily in English, maybe don't chose "the" as your abbreviation for "Transportable Helicopter Enclosure". But there are certain circumstances when even the unlikeliest of Abbrevs will expand when you don't want them to.[261]

[261] Like, when you're writing about "sk" being an abbreviation for Székelykáposzta, for example...

When exactly *do* Abbrevs expand? When you've enabled `abbrev-mode`, Abbrevs are checked for every time you type a *non-word-constituent* character, that is, any character that the current Major Mode doesn't consider to be a part of words. Typically that's whitespace and punctuation. So when you type "The End.", as soon as you type the space, `abbrev-mode` checks the preceding word ("The") to see if it's an Abbrev, and if so it expands it. Then when you type the period after "End", it checks to see if "end" is an abbrev, and so on.

This means that you might get an unwanted expansion. This is especially common when you're briefly typing in a domain specific language in your otherwise straight natural language prose. Suppose I need to type a URL in my Transylvanian cooking text, and the URL includes an innocent "sk" between punctuation characters, like `https://example.com/d7/sk/45/d0/` — I would end up with `https://example.com/d7/Székelykáposzta/45/d0/`! This can also come up with snippets of HTML, say, or examples from some programming language.

There are two solutions. One is, as soon as you see the unwanted expansion, Undo it. This will lose you the punctuation character that caused the expansion — a slash, above — so then add the slash back by quoting it with `C-q` (`quoted-insert`) i.e. `C-q /`. `quoted-insert` prevents `abbrev-mode` from expanding the Abbrev. If you're thinking ahead you can obviously skip the Undo part.

Another solution is to use `M-x unexpand-abbrev`, which does just what it says; you'll still need to use `quoted-insert` to get the punctuation back.

A real downside is that you might be typing quickly and *not notice* the expansion! Now you have an error: this is the same reason your SMS text messages are full of embarrassing typos, and is the reason I don't really use Abbrevs very much. I prefer Dynamic Abbrevs: if I'm typing Székelykáposzta often enough, it'll be sure to complete easily with `M-/`.

Prefixed Abbrevs

The inverse of unwanted expansions is wanted expansions that don't happen. Suppose you've defined "bac" as an Abbrev for "bacterial", and you expect that when you type "antibac " it will expand to "antibacterial". But of course it doesn't, because the word preceding the space isn't "bac".

You can solve this with `M-'` (`abbrev-prefix-mark`). Just type "anti" `M-'` "bac" and then space; when you type `M-'` Emacs will insert a hyphen, but this is a magic hyphen, and when you hit the space, "anti-bac" will expand to "antibacterial" (and the hyphen disappears).

Turning `abbrev-mode` on in Your Init File

Unlike many modern Minor Modes, `abbrev-mode` doesn't have a `global-abbrev-mode` version, so if you want it on in all the Major Modes you use, you'll have to enumerate them in your Init File. The easiest way is probably to use one or both of these two hooks:

```
(add-hook 'text-mode-hook 'abbrev-mode)
(add-hook 'prog-mode-hook 'abbrev-mode)
```

Most texty Major Modes inherit from `text-mode`, just as most programming language modes inherit from `prog-mode`. If you don't want it everywhere, just add it to the hook for any Modes you want; see *Hooks*.

Listing and Editing Abbrevs

You can see all the Abbrevs that you've defined with `M-x list-abbrevs`. They're grouped by Major Mode and will include a special entry for the Global Abbrev Table. Most definition lines will look like:

```
"sk"           32   "Székelykáposzta"
```

You can edit any of these lines to tweak or add new Abbrevs. The number in the middle is a count of how many times you've used that Abbrev, which can be helpful if you decide to clean some of them up. You can also delete lines to delete the definition. After making any such changes, `C-c C-c` (`edit-abbrevs-redefine`) will update Emacs's state to reflect your changes. `C-x C-s` will save the buffer in a file that Emacs will automatically load each time you start a session.

Saving Your Abbrevs

If you've defined any Abbrevs in a session, Emacs will ask if you want to save them when you run `C-x s` (`save-some-buffers`), or when you exit. When prompted for a filename to save them in, the default will be a file in your Emacs Directory; Abbrevs in this file will be loaded and defined for you when you start up Emacs.

Recursive Edit

One of the more unusual Emacs capabilities is what we call *Recursive Edit*; it refers to your ability to do full-on Emacs editing while you're in the middle of doing Emacs editing. What?

Suppose you're doing a Query Replace, which is a very structured sort of editing: you're stepping from one match to the next and at each stage, answering a yes-or-no-question (replace this one, or not). It's possible that in the middle of this, you might need to look at some other part of the buffer, or some other Buffer entirely, in order to decide between yes or no for one of the matches. You could quit the Query Replace, and then restart it, but the normal Emacs thing to do is enter a Recursive Edit—which, in a Query Replace, you can do by using `C-r`.

The Recursive Edit is a way to leave the Query Replace frozen where you left it. You can then do *any* Emacs editing you like: you're no longer just answering yes or no. You can scroll the Buffer, move to a different location, make a quick edit, change Buffers, send an email, or play a game of Tetris. Take as much time as you like, even days if you want (as long as you don't exit Emacs).

It will seem as if you've quit out of the Query Replace, but really it's just waiting patiently for you to end your Recursive Edit, at which point your windows will be restored to exactly what they looked like when you hit `C-r`, and it will be waiting for you to answer the exact same yes or no question it was asking you before your excursion.

The word *recursion* implies self-reference and nesting something within itself, as in the recursive acronym GNU, which stands for "GNU's not Unix!"[262]. This is exactly what's happening with a Recursive Edit: in order to let you do an arbitrary something in the middle of something else, rather then implementing a half-assed temporary-escape feature, Emacs does the simplest possible thing: it calls itself recursively to do the job. This simplest possible thing also happens to be the most powerful thing.

[262] : The "GNU" stands for "GNU's not Unix!".

The only way you can tell you're in a Recursive Edit is by peeking at the Mode Line. The section which displays Major and Minor

Modes with parentheses will be wrapped in square brackets, like this:

```
U:@---  *scratch*    All L1   Hg:94daf  [(Lisp Interaction ElDoc)]
```

when you exit the Recursive Edit, the brackets will go away.

Since you can do *anything* while you're in a Recursive Edit, that includes entering another Recursive Edit! If you do that, you'll see another level of brackets in the Mode Line. The number of pairs of brackets indicates how deeply nested you are.

Besides Query Replace, you'll find special key-bindings for Recursive Edit in other highly-structured Emacs subsystems, like Keyboard Macros and the Elisp debugger. But because Emacs is very much a non-modal editor, there's less call for special uses of this powerful feature than you might think. If you're doing file management in Dired, or are the middle of editing a version control log message, you can just switch Buffers, do something else, and come back later. This is even true when you're being prompted for information, as I described in *The Minibuffer*.

You *can* invoke a Recursive Edit manually whenever you want with `M-x recursive-edit`, but I'm hard pressed to think of times when I've wanted to do this.

Exiting a Recursive Edit

I encourage you to try a recursive excursion during your next Query Replace. But before you do, you need to know how to exit the Recursive Edit! There are three ways:

`C-M-c` *(`exit-recursive-edit`)* exit the innermost Recursive Edit and continue where you left off (perhaps back in your Query Replace)

`C-]` *(`abort-recursive-edit`)* same as above, but also abort the command that gave you the Recursive Edit (perhaps your Query Replace)

`M-x top-level` abort *all* nested levels of Recursive Edit

If you ever happen to notice some square brackets around the mode information in your Minibuffer, it might be because you accidentally entered a Recursive Edit, or perhaps days ago you intentionally did so in a Query Replace but then changed your mind entirely about it, and simply forgot to exit — you might even have killed the Buffer in which you were doing the Query Replace! `C-]` is appropriate in these situations, but `C-M-c` is the standard procedure.

A forgotten Recursive Edit rarely causes any problems — you could be working for weeks in one without even noticing — but you might as well clean them up when you discover them.

Visual Display and Color

Each character or span of characters in a Buffer can have any number of *properties* that can be used to change its *Face* (font, colors, underlining, slant, etc), directionality (left-to-right or right-to-left), spacing and line-height, margins, visibility, modifiability, and the like. Chunks of text of any size can have clickable actions or an entire menu associated with them and can change what a keystroke does when the cursor is at a particular location. Text can be displayed as glyphs (like emojis or icons) or full-blown images. All of this is done without any modification to the plain text of the Buffer's visited file (if any) and so won't interfere with or confuse external programs.

These facilities are used to build Emacs applications such as the Customize facility and Dired, and one generally needs to be an Elisp programmer to play with them, but here we'll discuss some of the user-level commands that enable non-programmers to easily change the visual properties.

Fonts and Faces

Loosely speaking a *computer font* (hereafter, just "font") is a packaging of a particular typeface design (think Helvetica), including variations in size, weight, slope, and the like. Your operating system comes with some fonts predefined, and you may have added many more via your OS package manager. More precisely, a font is one specific expression of a typeface, a weight, a slant, etc, such as "Helvetica 14 Bold". I have 1,863 fonts installed on my system, which are all available to Emacs.

A *Face* is an Emacs concept: a combination of a font with any of the following additional attributes: Underline, Overline, Strikethrough, Box around text, Inverse-video, Foreground (color), Background (color), or Stipple.[263]

Emacs predefines 150-odd different Faces, and packages can define and add many more (my Emacs currently has 439). You can see a colorful listing of all the currently defined Faces with `M-x list-faces-display`.

[263] A Face can also override the font's Width, Height, Weight, or Slant.

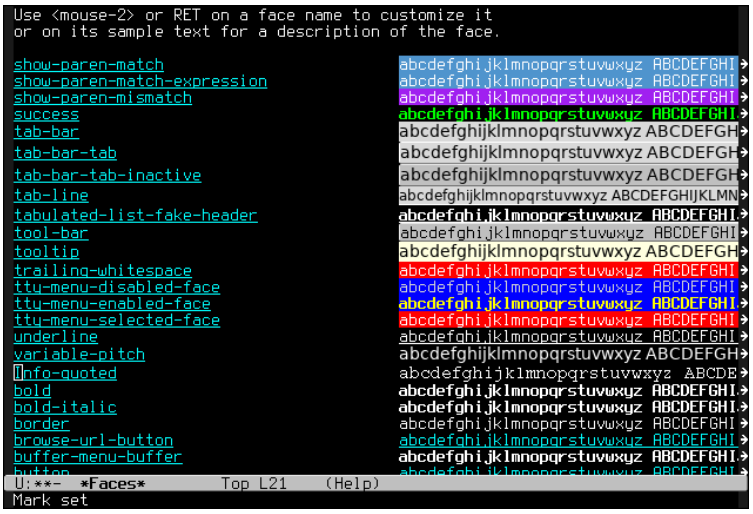


Figure 43: `M-x list-faces-display`

These Faces are used to present the typically colorful Emacs display of mode-specific syntax highlighting, hypertext links: really, everything, because in Emacs, all is text.

You don't need to worry about specific Faces until you're unhappy with one. If some Face in some mode rubs you the wrong way, you can easily change it; see Customize for more information.

Changing the Default Font

Most Faces are just customized versions of the *default font*[264], and the default font is what most of your text will look like. You may want to change it from the default 10-point monospace font. As a programmer, I much prefer a monospace (fixed-pitch) font, but I like a specific one best and specify it in my Init File. You can do this yourself with something like this:[265]

[264] The `success` font visible in Figure 43 is just the default font in bold with a bright green foreground color.

[265] I use `with-demoted-errors` so my Init File will still work even if I haven't installed my preferred font (which is not actually Helvetica).

```
(with-demoted-errors "%s"
  (add-to-list 'default-frame-alist '(font . "Helvetica 12")))
```

Changing Fonts on the Fly

The default font is Frame-specific; though there's a default, you can change the current Frame's font on the fly with `M-x set-frame-font`; you can use Completion to choose amongst all the fonts available on your system. `M-x menu-set-font` provides a popup GUI dialog and changes the font of *all* your existing and future frames (in the current Emacs session) in one go.

You can of course customize different fonts for different Major Modes and the like, and there are a number of third-party packages for working with fonts as well.

Text Scale: Changing the Font Size

Once you've chosen your default font, you probably won't often feel the need to change it on the fly, but you may well want to change the *size* from time to time. You can increase the font size with `C-x C-+` (`text-scale-adjust`), which immediately embiggens the font by the factor in `text-scale-mode-step` (default: 1.2), or decrease the font size by the same factor with `C-x C--` (`text-scale-adjust`); `C-x C-0` (`text-scale-adjust`) will restore your default font size.

You may have noticed that all these keystrokes are bound to the same function. That's because the `text-scale-adjust` function bases its behavior on the keystroke that invoked it. Additionally, after it's invoked, if any of the next keystrokes in unbroken sequence are `0`, `+`, or `-`, ignoring any modifiers, the corresponding action is invoked. In short, start with any of `C-x C-0`, `C-x C-+`, or `C-x C--` and then you can continue tweaking the font size with simple `0`, `+`, or `-` keystrokes until you get what you want — terminate this with any key that doesn't involve `0`, `+`, or `-` (`C-g` (`keyboard-quit`) is always there for you).

Since for me, the first adjustment is always to *enlarge* the font, I bind `text-scale-adjust` to the felicitous binding `C-+` and start from there:

Init File

```
(keymap-global-set "C-+" 'text-scale-adjust) ; embiggen font
```

Themes and Colors

A *theme* is a named combination of Faces[266] that broadly determines the overall look of your Emacs, especially the colors. Emacs predefines 17 Themes, and there are at least 319 more in the Package Manager, and many more on Github and the like.

[266] Strictly speaking, a Theme can customize Variables as well as Faces.

If you'd like to change your Theme, just call `M-x customize-themes`, which will contain lines like:

```
[ ] wheatgrass -- High-contrast green/blue/brown faces on a black background.
[ ] whiteboard -- Face colors similar to markers on a whiteboard.
[ ] wombat -- Medium-contrast faces with a dark gray background.
```

Just check the box of the Theme you want and the Theme will be immediately activated; check another box and it will switch to that theme; uncheck the box to go back to Theme you were using before you started. Some Themes are subtle and you might need to see them in a variety of different types of Buffers to appreciate them. Third-party Themes you've installed from the Package Manager will also be listed in this Buffer. After you've chosen the one Theme you like,

you can make it your default for future sessions: evaluate `C-x C-s` (`custom-theme-save`) in the Customize Buffer.

Who creates all these Themes? Anybody, including you. If you want to try your hand at it, run `M-x customize-create-theme` and answer "yes" to the question:

```
Include basic face customizations in this theme? (y or n)
```

You'll be taken to a special Customize Buffer where you can choose all the colors, fonts, and faces you want in your very own Theme, which you can save, make your default, and even give away to other Emacs users.

Colors

One of the most important parts of a Theme is its (presumably harmonious) color choices. On my system, Emacs knows 752 named colors; you can examine them via `M-x list-colors-display` (see Figure 44).

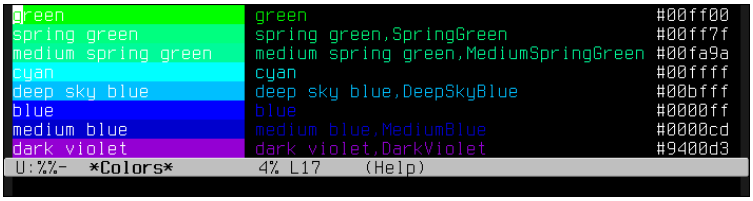


Figure 44: `M-x list-colors-display`

The Cursor

Every Window has a Point, which is indicated by a *cursor*. By default, the cursor is a solid block in the currently selected Window, and a hollow block in any other visible Windows. But you can change how the cursor is displayed if you like. Customize the many aspects of the cursor with `M-x customize-group RET cursor`. See "Cursor Display" in the *Emacs* manual for more information.

By default, the cursor blinks, which drives me crazy; I turn it off in my Init File:

```
(blink-cursor-mode 0)
```

Emphasizing the Cursor's Line

When I'm reading text with long lines, I sometimes lose my focus as I scan the lines from left to right; it's also an issue for me vertically with very tall windows. To solve this problem, I invoke `M-x hl-line-mode`, which changes the background of the entire line containing

Point (i.e. the cursor) to make that line stand out. As you move the Point from line to line, the background emphasis follows along.

I turn this on automatically in many Major Modes that display lists of things, like `package-menu-mode`, `occur-mode`, and `dired-mode` via Init File snippets like these:

```
(add-hook 'occur-mode-hook 'hl-line-mode)
(add-hook 'dired-mode-hook 'hl-line-mode)
(add-hook 'package-menu-mode-hook 'hl-line-mode)
```

Highlighting Text

By now you've noticed how colorful the typical Buffer is. Almost every Major Mode does a certain amount of what we call *fontification* to apply Faces based on the structure or syntax of the text. This is typically done by a Minor Mode called `font-lock-mode`, which is enabled globally by default. If you're looking at a colorful Buffer right now, try saying `M-x font-lock-mode` and you'll be stunned to see all the colors disappear: you'll be staring at 100% monochrome text! This is what Emacs used to look like in the 70s. (Quick! Reinvoke that command to get your colors back!)

Fontification is mostly performed by Major or Minor Modes, so you have to be an Elisp programmer and Regular Expression wizard to do it. But there is a small collection of commands that allow you to fontify your text *dynamically*: we call this on-the-fly fontification *highlighting*.

Hi-Lock Mode

`hi-lock-mode` lets you highlight text that matches certain patterns, to make occurrences of those patterns stand out dramatically. As a programmer, I often use it to highlight the name of a function or variable in my code so that all the uses jump out at me; you might also use it to highlight the names of people or things in a document so that they stand out as you scroll through. It looks rather like the highlighting of your search term that Incremental Search does, but the Isearch highlights disappear as soon you terminate your search: Hi-Lock highlighting sticks around until you turn it off.

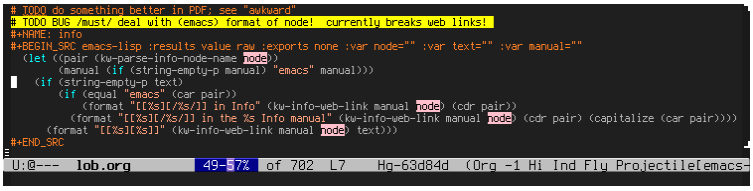


Figure 45: Highlighting with `M-s h`

In Figure 45, I've highlighted all occurrences of the variable `node` in pink. All the occurrences in the Buffer are pink, not just the ones visible in the Window: as I scroll the Buffer, any `node` I see will be pink, and if I type new text that contains `node`, that new `node` will immediately become pink as well. In addition, I've highlighted a comment describing a bug in unmissable yellow; all other comments that start with `TODO BUG` will also be lit up this way. I consider Hi-Lock Mode an essential feature and use it all day long.

Note that these highlights don't modify your text in any way. If you save your file, they won't corrupt your program with hidden codes. On the other hand, if you want them to come back the next time you edit your file, you have to say so.

The Hi-Lock commands all live on the `M-s h` prefix; see Table 40.

Table 40: Hi-Lock Mode Commands

Key	Action
`M-s h .`	highlight symbol at Point
`M-s h p`	highlight a given Phrase
`M-s h r`	highlight text matching a Regexp
`M-s h l`	highlight Lines containing matches
`M-s h u`	Unhighlight a previous highlight
`M-s h f`	hi-lock-find-patterns
`M-s h w`	hi-lock-write-interactive-patterns

The simplest command is `M-s h .` (`highlight-symbol-at-point`); just invoke it and the symbol[267] at Point, and all other occurrences of that symbol in the Buffer, will be highlighted in yellow.

[267] Remember, a *symbol* is like a word, but customized in programming language Major Modes to match the language's notion of a variable or function name. In ordinary text, you can use this command to highlight words.

Actually, not always in yellow: the *next Hi-Lock color* will be used. Hi-Lock has a default list of colors it uses; if you've already highlighted something in yellow, it will use the next color to avoid a conflict. You can explicitly choose your own color by giving `M-s h .` a prefix arg.

And as a matter of fact, Hi-Lock doesn't highlight with colors: it uses *Faces*. You'll recall that Emacs comes with 150 or so, and you can use any of them for highlighting.

Instead of highlighting the symbol at Point, `M-s h p` (`highlight-phrase`) prompts you for a phrase: that is, a sequence of words, and highlights matches. It ignores case and whitespace distinctions when looking for matches. Of course you can use a one-word phrase, which is like highlighting a symbol which doesn't happen to be right at Point.

`M-s h r` (`highlight-regexp`) prompts you for a Regular Expression and a Face, and then highlights all the matches, and `M-s h l` (`highlight-lines-matching-regexp`) works the same way except it highlights the entirety of any lines that *contain* the matches. This is what I used in Figure 45 to highlight the Regexp `TODO BUG`.

Of course you can remove any of the highlighting you've applied, with `M-s h u` (`unhighlight-regexp`). It will prompt you to select one of the patterns you've used and it will eliminate that one. With a prefix arg, it will remove *all* the patterns you've used in this Buffer.

I mostly use Hi-Lock transiently throughout the day. turning it on and off to enhance my focus as I work, but you can also set up persistent highlighting for a given file that will be automatically applied every time you visit the file.

Visualizing Whitespace

Whitespace—spaces, tabs, newlines, blank lines—is a big component of your text, but it can be an annoying component, mostly because it can be hard to tell these characters apart.[268] Sometimes you don't care about such subtle distinctions, but sometimes, depending on what kind of program will be consuming your text, you need to.

[268] Especially with a proportional font, in my opinion.

`M-x whitespace-mode` is a Minor Mode that can help by displaying the various sorts of whitespace with a subtle (or not so subtle) differentiation. In Figure 46 I've toggled it on.

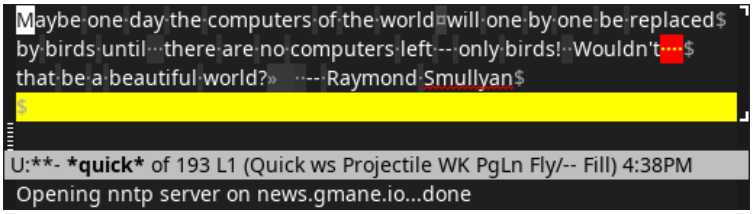


Figure 46: `M-x whitespace-mode`

Spaces are shown as a centered dot in a gray background, which makes the excess spaces between "until" and "there" more noticeable; the space between "world" and "will" is a non-breaking space, and is shown differently. Newlines are shown as a gray dollar sign, and there's a TAB character after the question mark shown as a right-pointing guillemet.

These are all pretty subtle, so that `whitespace-mode` isn't *too* jarring to use.

But the trailing spaces on line 2 *really* stand out, as does the trailing blank line at the end of the Buffer, since these are considered to be always offensive.

You can use `M-x customize-group whitespace RET` to change these Faces if you want them to be more or less noticeable.

`whitespace-mode` has *a lot* of options that you can customize, and you can also interactively tweak them on and off in a given buffer with `M-x whitespace-toggle-options` — type `?` at the prompt.

If you want `whitespace-mode` on all the time in all your Buffers,

you can use `M-x customize-variable global-whitespace-mode`. Personally I only occasionally turn `whitespace-mode` on, but it's very handy when I need it.

However, I do want to always see trailing whitespace at the ends of lines, since it annoys me and I want to clean it up. You don't need `whitespace-mode` for this; just do `M-x customize-variable show-trailing-whitespace`.

It's easy to get rid of trailing whitespace when you notice it (as you will, with this setting): `M-x delete-trailing-whitespace` will delete all trailing whitespace in your Buffer, including all blank lines at the end of the Buffer. If the Active Region is enabled, only the text in the Region is processed. You could put this function in `before-save-hook` so that these are cleaned up every time you save, but that's a little too helpful for my tastes.

Manipulating Plain Text

Emacs's many modes and applications represent structured data as plain text. In this chapter we'll look at some commands that are useful for manipulating text in a variety of domains and Modes. For other facilities that are most useful for prose, see *Emacs for Writers*.

Mass Line Deletions

Data is often arranged in the form of lines, and a frequent operation is to reduce it: either by deleting certain lines or by keeping only others (which amounts to the same thing). You can delete all the lines after Point that match a Regular Expression in one stroke with `M-x flush-lines`, or the converse with `M-x keep-lines`. Complete lines are deleted (or kept) regardless of how much text your Regexp matches: `M-x flush-lines RET foo` deletes all the lines that contain `foo` anywhere in the line. Both of these functions instead operate on the Region if it is Active.

Your Regexp can cross line boundaries like, say, `foo[[:space:]]+bar`, which will match `foo` and `bar` separated by whitespace, including newlines; in this case the entirety of all the lines containing the match will be deleted.

Emacs makes a distinction between *deleting* and *killing*: text that's deleted is simply thrown away[269], while text that's killed is put on the Kill Ring and so can be yanked back.

[269] Of course, you can always Undo…

There's a variation on `flush-lines` called `M-x kill-matching-lines`, which works in exactly the same way except instead of deleting, it *kills* the lines, so they are pushed onto the Kill Ring in one bunch. This makes it a good way of moving a bunch of discontiguous lines, or even of copying them, if you immediately Undo after killing them.

`M-x delete-duplicate-lines` is a powerful function that deletes all but the first of any identical lines in the Region. So if the Region contains the eight lines in column one of Table 41, then after `M-x delete-duplicate-lines` it will contain only the lines in column two. You'll note that the order of the remaining lines stays the same, so

Table 41: `M-x delete-duplicate-lines`

Before	After
foo	foo
bar	bar
baz	baz
bar	zap
bar	
zap	
foo	
baz	

this isn't simply `C-u M-| sort -u`....

Sorting Lines

Emacs has a powerful set of commands that sort lines, distinguished by how they interpret the sort field.

The simplest is `M-x sort-lines`, which uses the entire line as the sort field. `M-x sort-fields` sorts based on whitespace-separated fields within the line; use a numeric argument to specify which field; the default is 1. `M-x sort-numeric-fields` works the same way, but interprets the contents of the sort fields numerically. In both cases, if you specify a negative field number, it means to count the fields from the *right*, so `C-u -1` would sort on the last field in each line.

Here are some examples. In column one of Table **??**, I generated 10 random words and paired them with 10 random numbers. Columns 2-4 illustrate different sorts. Note that in this example, `sort-lines` would happen to be the same as `sort-fields`, which is also the same as `C-u 1 sort-fields`. In column 3, France comes first because the sorting functions all work case-sensitively, and upper-case letters precede lower-case letters. `sort-numeric-fields` is the same as `C-u 1 sort-numeric-fields`.

Table 42: Different Sorts

Random	`sort-lines` `sort-fields` `C-u 1 sort-fields`	`C-u 2 sort-fields`	`sort-numeric-fields` `C-u 1 sort-numeric-fields`
16 honkers	16 honkers	34 France	2 err
39 oysters	2 err	5 Madge	3 cuddling
99 disheartening	3 cuddling	59 corny	5 Madge
5 Madge	34 France	45 cranks	16 honkers
2 err	39 oysters	3 cuddling	34 France
3 cuddling	45 cranks	99 disheartening	39 oysters
59 corny	5 Madge	2 err	45 cranks
57 huskiest	57 huskiest	16 honkers	57 huskiest
45 cranks	59 corny	57 huskiest	59 corny
34 France	99 disheartening	39 oysters	99 disheartening

All of these sorts are what programmers call *stable sorts*: that is, the

relative order of records with equal keys is maintained. This means you can sort a Region again to achieve a sub-sort.

`M-x sort-columns` lets you indicate the sort field as a rigid range of (single-character) columns. You do this by effectively defining the sort fields via a Rectangle: the upper-left-hand corner of the rectangle determines the starting column of the sort field, the width of the Rectangle in characters determines the width, and the height of the Rectangle in lines determines the range of lines to sort.

Consider this (slightly modified) excerpt from the table of contents of the Emacs Manual. We want to sort these lines by the heading (e.g. "Basic Undo"), ignoring the summary descriptions. We can't use `sort-lines` because the numbers will result in no change to the order. We can't use `C-u 2 sort-fields` because some of the headings are two words long and some aren't: we want "Basic Help" to sort before "Basic Undo", but `sort-fields` is sorting *only* on the second field, so all the "Basic"'s will retain their relative order, due to the stability of the sort.

```
1 Erasing::             Deleting and killing text.
2 Basic Undo::          Undoing recent changes in the text.
3 Basic Help::          Asking what a character does.
4 Basic Files::         Visiting, creating, and saving files.
5 Blank Lines::         Making and deleting blank lines.
6 Position Info::       What line, row, or column is point on?
7 Arguments::           Numeric arguments for repeating a command N times.
8 Repeating::           Repeating the previous command quickly.
9 Continuation Lines::  How Emacs displays lines too wide for the screen.
```

The solution is to set the Mark in front of "Erasing" and Point in front of "How" on line 9, defining a Rectangle that encompasses the entire width of the columns we want to use as the sort field. Now `M-x sort-columns` will sort the lines correctly, resulting in:

```
7 Arguments::           Numeric arguments for repeating a command N times.
4 Basic Files::         Visiting, creating, and saving files.
3 Basic Help::          Asking what a character does.
2 Basic Undo::          Undoing recent changes in the text.
5 Blank Lines::         Making and deleting blank lines.
9 Continuation Lines::  How Emacs displays lines too wide for the screen.
1 Erasing::             Deleting and killing text.
6 Position Info::       What line, row, or column is point on?
8 Repeating::           Repeating the previous command quickly.
```

Ignoring Case Distinctions

I mentioned that the sort commands are case-sensitive, which is why France comes first in the `C-u 2 sort-fields` example above. You can sort in a case-insensitive manner as well, but it's a little awkward: you have to change the variable `sort-fold-case` from its default of `nil` to `t`:

```
M-x set-variable RET sort-fold-case RET t
```

You'll have to remember to change it back to `nil` unless you're happy with case-insensitive sorting for the rest of your session. If you like, you could make that variable Buffer Local before changing it, with `M-x make-variable-buffer-local`.

Reversing Lines

You may have noticed that there seems to be no way to sort in reverse order, and you're right. But you can always just reverse the order of all the lines you just sorted with `M-x reverse-region`. `reverse-region` can of course also be used on unsorted lines.

Numbering Lines

`display-line-numbers-mode` and `global-display-line-numbers-mode` display line numbers in the Fringe, but you may need to occasionally actually insert line numbers into your text. We've already discussed two ways to do this: using a counter in a Keyboard Macro, or using `C-x r N` (`rectangle-number-lines`), which is usually easier: see *Rectangles*.

Whitespace and Blank Lines

Whitespace and blank (empty) lines are a common feature of most Buffers. *Whitespace* encompasses several distinct but easily confused characters, most notably the space (ASCII 32 or #x20) and tab (`C-i`, ASCII 9 or #x09). Those two are confusing enough already without throwing in the formfeed (`C-l`, ASCII 12 or #x0C) and the little known *vertical tab* (`C-k`, ASCII 11 or #x0B). The newline (`C-j`, ASCII 10 or #x0A) and carriage return (`C-m`, ASCII 13 or #x0D), the two possible line terminators, also count as whitespace in some contexts. And then there are all the Unicode whitespace characters, like the en and em spaces, the thin and hair spaces, and the whole family of non-breaking spaces!

The mere visibility of these characters and how to distinguish them on the screen is its own topic.

It's no wonder there are several commands for dealing with whitespace; see also the related topic of *Filling and Indenting*.

Tabs vs. Spaces

Inserting a space is as simple as hitting the space bar (`SPC`), but how do you insert a tab character? It's not as simple as hitting the tab key, because `TAB` is typically bound to a special command for indenting lines; even in `fundamental-mode` it's bound to `indent-for-tab-command`. The guaranteed way to insert a single, actual, tab is via `C-q` (`quoted-insert`) followed by the `TAB` key (see *Inserting Non-Printing Characters*).

Probably more common than needing to insert a guaranteed tab is needing to remove them. Tabs often cause problems in data files and source code for languages that are especially picky about indentation[270]. Of course it's easy to change each tab to one space with `M-%` (`query-replace`), but what if you want to preserve the relative horizontal spacing? The `M-x untabify` command will replace all the tabs in the region with one or more spaces, preserving the horizontal spacing. That is, any given tab will display as one or more spaces to expand to the next tab stop; `untabify` reifies each tab into as many actual spaces as it takes to reach the same tab stop.

[270] I'm looking at you, Python...

If you're confused, or just never understood that *Silicon Valley*[271] episode, see Jamie Zawinski's explanation.

[271] Season 3, Episode 6: "Bachmanity Insanity".

Horizontal Whitespace

Sometimes your Buffer will contain several horizontal whitespace characters in a row, like 5 spaces or a space and a tab. There are two handy ways to get rid of the excess. `M-\` eliminates *all* the whitespace around Point, while `M-SPC` (`cycle-spacing`) replaces it all with just one actual space character (with a numeric Arg, it replaces them with exactly that many spaces). Note that these two commands only treat in spaces and tabs, but not any of the more exotic whitespace characters like formfeeds and non-breaking spaces.

If you're like me and consider *trailing whitespace*—i.e., whitespace characters following the last non-whitespace character on a line—to be, in general, an intolerable offense, you can rid yourself of all of these within the Region with `M-x delete-trailing-whitespace`. This command works on all horizontal whitespace characters except formfeeds.[272]

[272] Formfeeds are excluded by these commands to preserve their usefulness in separating files into pages.

Blank Lines

Blank lines and empty lines also have some handy commands. You can of course create a new empty line by hitting `RET` (`newline`) a few times; this takes the usual numeric Arg so you can insert, say, four new lines with `C-u RET` or seven with `C-u 7 RET`. This leaves Point after the last newline. The more precise `M-x ensure-empty-lines` works like this but guarantees exactly *N* empty lines, where *N* is the value of the prefix argument.

Sometimes you want Point to be *before* the new newlines, which is what `C-o` (`open-line`) is for. It's especially useful for working with Rectangles, Picture Mode, and Artist Mode, where you need a big block of blank lines in which you can do two-dimensional things.

`C-x C-o` (`delete-blank-lines`) is the inverse of `C-o`: when Point is in the middle of a bunch of consecutive blank lines, `C-x C-o` reduces them to just one blank line; an additional `C-x C-o` removes that remaining blank line too.

What's the difference between a *blank* line and an *empty* line, exactly? An empty line is what you get when you have two newlines in a row: to be precise, two newlines with an empty string between them. A blank line is two newlines with nothing but zero or more whitespace characters between them. So a line full of nothing but spaces and tabs is a blank line, but not an empty line.

There's a variant of `C-o` that splits a line in two, vertically rather than linearly: `C-M-o` (`split-line`). Here Point is represented by `|`:

```
Lorem ipsum dolor sit amet, |consectetuer adipiscing elit.
```

The result of a `C-M-o` would be:

```
Lorem ipsum dolor sit amet, |
                            consectetuer adipiscing elit.
```

`M-^` (`join-line`) (a.k.a. `delete-indentation`) joins the current line (containing Point) to the end of the previous line, regardless of Point's exact location in the current line. It ensures that there will be one space between the joined lines; Point is positioned at that space (which you could immediately eliminate with `M-\`).

This all means that if you repeatedly invoke `M-^`, it will join together several previous lines, going backwards. So if Point is in front of "baz":

```
foo
bar
|baz
```

two `M-^`'s will result in:

```
foo| bar baz
```

Indenting Lines

Indentation—that is, the presence or absence of whitespace at the beginning of a line—is an annoyingly complex topic. Fortunately, it's less complex than it used to be decades ago, but Emacs of course still supports all the old-school complexity. I think we can ignore most it!

Indentation is primarily a concern when you're editing structured text: programming languages, like Elisp or Python; data interchange languages, like JSON; or markup languages, like HTML and Latex. Emacs has a Major Mode for almost every such language you might need to work with, and these Modes understand the indentation requirements or conventions and handle it for you. Mostly, it boils down to this: just hit `TAB` (wherever you may be in the line) to indent the current line correctly.

The topic is most complex when you're editing prose in a Major Mode like `text-mode`. But who edits plain text prose anymore? Decades ago I used `text-mode` all the time, but I probably haven't used it for 10 or more years. Now I do all my prose in the amazing Org Mode, which uses a form of structured text that makes straight prose more readable than `text-mode`, and yet lets me publish it as plain text, HTML or a PDF[273] with a keystroke. And as a structured text mode, Org handles indentation automatically.

[273] And many more formats...

So the only kind of indenting I'm going to discuss here is *rigid indentation*, which you may occasionally need to do in any random mode. The main command is `C-x TAB` (`indent-rigidly`): just set the Region around a bunch of lines, and `C-x TAB` will prompt you:

```
Indent region with <left>, <right>, S-<left>, or S-<right>.
```

You're in a transient mode for as long as you hit any unbroken sequence of the mentioned keystrokes; typing any other key will exit the mode (and do whatever that other key is supposed to do).

`<right>` and `<left>` will indent or *dedent*, respectively, the whole block of lines one column at a time. The shifted versions will move in larger jumps of 8 columns at a time.[274] With a positive or negative numeric argument, it will increase or decrease the indentation by exactly that many characters. The related command `C-M-\` (`indent-region`), with a numeric argument, will re-indent all the lines in the Region to the column indicated by the argument: `C-u 12 C-M-\` will leave you with all the lines indented 12 spaces from the left, regardless of how much each line was already indented.

[274] Technically, they move to the next or previous *tab stop*; see below.

The command `M-m` (`back-to-indentation`) conveniently moves Point to the first non-whitespace character on the line: it's like a `C-a` for indented lines.

Tabs and Tab Stops

In many Major Modes, `TAB` is bound to `indent-for-tab-command`, which typically[275] causes Emacs to insert enough whitespace to move Point to the next *tab stop*. A tab stop is one of a set of specific column numbers or horizontal positions, the idea being to use them to line your text up in columns.

If there are no explicit tab stops defined, the default is every 8 columns.[276] You can define tab stops at arbitrary positions (for the current Buffer) by invoking `M-x edit-tab-stops`.

Frankly, tab stops are not much used anymore, because, as mentioned above, people tend to use markup languages instead of manually laying out plain text. So I'll say no more on this topic.

However, since TAB characters cause problems—they're hard to distinguish from runs of spaces, their displayed width varies depending on the tab stops so they can seem to have different widths to different people, and their presence can confuse certain programs—I recommend telling Emacs never to implicitly insert them, and to always use runs of spaces instead; this Init File snippet does that. Because EIPNIF, you can of course always insert a real tab with `C-q TAB`.

Init File

```
(setq-default indent-tabs-mode nil)      ; don't insert tabs
```

Since you might encounter tabs in a file authored by someone else, you can readily convert all tabs in the Region to equivalent runs of spaces with `M-x untabify`; the inverse (rarely needed) is `M-x tabify`.

[275] I say *typically* because this is very malleable command whose exact behavior depends on the Major Mode and the values of various User Options.

[276] Actually, the value of `tab-width` is used.

Case Changing

There are three ways to change the case of your alphabetic text: converting it to all-uppercase, to all-lowercase, and to capitalize the first letter of each word. There are two modes of invoking these case changes: by word or by region.

	Word	Region
Upcase	`M-u` (`upcase-word`)	`C-x C-u` (`upcase-region`)
Downcase	`M-l` (`dowcase-word`)	`C-x C-l` (`downcase-region`)
Capitalize	`M-c` (`capitalize-word`)	`M-x capitalize-region`

The by-word commands change the case of the next word (leaping over intervening non-alphabetic characters), or with a prefix arg, the next N words (a negative argument works backwards); Point moves across each converted word. So you can upcase the next several words in a row with repeated invocations of `M-u`, for example.

The by-region commands operate on the Region without moving Point. Note that `upcase-region` and `downcase-region` are Disabled by default, just because beginners, who aren't comfortable with how easy it is to Undo changes, are often disturbed when they accidentally change the text of their entire thesis to all uppercase.

Tables

Emacs has a powerful set of commands for creating and editing plain-text tables. Here's a plain-text version of the Verlaines discography from Wikipedia:

```
+-------+------------+----------------+-------+-------------+--------+
|Date of|Title       |Label           |Charted|Certification|Catalog |
|Release|            |                |       |             |Number  |
+-------+------------+----------------+-------+-------------+--------+
|1985   |Hallelujah  |Flying          |-      |-            |FN040 / |
|       |All the     |Nun/Homestead   |       |             |HMS138  |
|       |Way Home    |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|1987   |Bird Dog    |Flying          |-      |-            |FN077 / |
|       |            |Nun/Homestead   |       |             |HMS095  |
+-------+------------+----------------+-------+-------------+--------+
|1987   |Juvenilia   |Flying Nun      |-      |-            |FN COMP |
|       |            |                |       |             |02      |
+-------+------------+----------------+-------+-------------+--------+
|1989   |Some        |Flying          |-      |-            |FN129 / |
|       |Disenchanted|Nun/Homestead   |       |             |HMS162  |
|       |Evening     |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|1991   |Ready to Fly|Slash           |-      |-            |C30718  |
+-------+------------+----------------+-------+-------------+--------+
|1993   |Way Out     |Slash           |-      |-            |D31032  |
|       |Where       |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|1996   |Over the    |Columbia        |-      |-            |486880.2|
|       |Moon        |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|2003   |You're Just |Flying Nun      |-      |-            |FNCD476 |
|       |Too Obscure |                |       |             |        |
|       |for Me      |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|2007   |Pot Boiler  |Flying Nun      |-      |-            |FNCD501 |
+-------+------------+----------------+-------+-------------+--------+
|2009   |Corporate   |Dunedinmusic.com|-      |-            |        |
|       |Moronic     |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|2012   |Untimely    |Flying Nun      |-      |-            |FNCD524 |
|       |Meditations |                |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
|2020   |Dunedin     |Schoolkids      |-      |-            |SMR-060 |
|       |Spleen      |Records         |       |             |        |
+-------+------------+----------------+-------+-------------+--------+
```

I created this by simply cut-and-pasting the Wikipedia table from the web page, which results, in my Buffer, in one line per row, with columns separated by tab characters. I set the Region around this and

invoked `M-x table-capture` and got the result you see above.

There are commands to split, merge, enlarge, and shrink cells, edit easily within a multi-line cell, justify cell contents, insert and delete rows and columns: it's very powerful.

The only question is, who needs attractive plain-text tables now that most documents are "typeset" from a markup language like LaTeX or Org Mode? Org Mode, in fact, has its own powerful markup for tables which in my opinion is much nicer to use—it's in many ways more powerful[277], though these plain-text tables are probably easier for multi-line cells.

[277] Including full programmable spreadsheet capabilities, for example.

The main use, nowadays, for this facility is probably for programmers who want to insert plain-text tables into comments in programming language source code. If you need these, see "Text Based Tables" in the *Emacs* manual.

References

Zawinski, Jamie. 2000. *Tabs Versus Spaces: An Eternal Holy War.* `https://www.jwz.org/doc/tabs-vs-spaces.html`.

Folding Text

It can be very useful to *fold* or collapse some of your text in order to ignore or to focus on certain parts, or to get an outline-like high-level overview. Emacs provides several subsystems to do this. They can be divided into two categories: one in which you must explicitly impose an outline- or tree-like markup to your text ahead of time, and the other which recognizes and folds text based on its implicit structure.

Markup-Based Folding

Emacs has had markup-based folding since the very beginning in the form of Outline Mode; it's basically Text Mode plus extremely simple markup to express your text in the form of an outline, which brings the ability to fold and unfold the headlines of the outline.

Outline Mode has additional commands to navigate by headline, and move headlines (and their folded components) up or down, or in and out (demoting or promoting them, headline-wise).

It's a big payoff for such a trivial amount of markup. But for most Emacsers, Outline Mode has been rendered obsolete by Org Mode.

Org Mode does exactly what Outline Mode does, with the same markup, but adds hundreds of additional features. If you think Outline Mode sounds useful, just skip directly to Org Mode instead: it'll be an improvement even if you aren't interested in its extra features.

Org Mode gets an entire chapter to itself; see *Org Mode* for details.

Implicit Folding

The problem with markup-based folding is of course the markup. But lots of text has implicit structure that Emacs can exploit for folding without your having to add any. Most programming languages, for example, have an implicit tree structure eminently suitable for folding. But even simple indentation can be used for folding purposes.

Hideshow Minor Mode

Hideshow Minor Mode is the high-level built-in mechanism for implicit folding. When enabled, you can fold function definitions in the source code of many programming languages. Consider this Python function from Wikipedia:

```
def qsort(L):
    if L == []:
        return []
    pivot = L[0]
    return (qsort([x for x in L[1:] if x < pivot]) +
            [pivot] +
            qsort([x for x in L[1:] if x >= pivot]))
```

With Point anywhere in the definition, you can fold it with one keystroke into this:

```
def qsort(L):...
```

Note the ellipsis ... at the end of the line, which indicates the presence of hidden folded text under this line (the dots are just for display and are not actually actually added to your text). Motion commands will skip over the ellipsis as if it were one character wide.

As with all the Emacs text folding subsystems, the invisible text is still there: you can search into it (which will unfold it), and if you copy a region that includes the folded text, the copied text contains all the hidden text as well; if you save the Buffer's file when some of the text is folded, you are of course saving all the hidden text as well, and there's no indication in the file that the text was folded (the next time you open the file, all your text will be there, unfolded).

You can unfold anything you've folded, and you can also fold and unfold all the top-level functions in one go. A Buffer consisting of hundreds of lines of code, when completely folded, would look something like:

```
def writable(path):...
def myurlopen(url, count = 0):...
def httpopen(scheme, hostport, path, parms, query, frag, count = 0):...

def snarf(url, clone):...
# checkout a locked version from rcs
def co(clone):...
# checkin (ci -l)
def ci(clone):...
```

Truth be told, I don't like Hideshow. For one thing, the default keybindings are just unusable. But this being Emacs, that's easily fixed. The bigger problem is that it doesn't work very well. It seems to work fine in `python-mode`, but in `c-mode` it does a bad job of recognizing function definitions, and it doesn't work at all for my favorite (non-Lisp) programming language, OCaml (which has an admittedly very free-form syntax). This is why I use the third-party library Yafolding instead; see below.

See "Hideshow" in the *Emacs* manual for more information. If you want to use it, try this Init File snippet that adds two usable key bindings for the most commonly used commands:

```
;; Hideshow for folding in programming modes
(add-hook 'prog-mode-hook 'hs-minor-mode)

;; from: Joseph Eydelnant
(defvar ue-hs-hide nil "Current state of hideshow for toggling all.")
(defun ue-toggle-hideshow-all ()
  "Toggle hideshow all."
  (interactive)
  (setq ue-hs-hide (not ue-hs-hide))
  (if ue-hs-hide
      (hs-hide-all)
    (hs-show-all)))

;; add usable key bindings
(with-eval-after-load 'hideshow
  ;; toggle hiding this block
  (define-key hs-minor-mode-map (kbd "C-<return>") 'hs-toggle-hiding)
  ;; toggle hiding all blocks in buffer
  (define-key hs-minor-mode-map (kbd "C-M-<return>") 'ue-toggle-hideshow-all))
```

Yafolding Mode

Zeno Zeng's Yafolding Mode is the package I prefer for folding text. It works great in every programming language I've tried, including OCaml with its nested function definitions expressed without any braces, because it just works based on indentation, which almost all programmers use consistently.

I only use two of its commands: `C-<return>` (`yafolding-toggle-element`) to toggle the folding of the "element" (typically a function definition) at Point, and `C-M-<return>` (`yafolding-toggle-all`) to toggle the folding of every element in the Buffer. This Init File snippet will set it up:

```
(unless (package-installed-p 'yafolding)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'yafolding)))
(add-hook 'prog-mode-hook
          (lambda () (with-demoted-errors "%s" (yafolding-mode +1))))
```

Selective Display

The simplest, but lowest level, text folding command is `C-x $` (`set-selective-display`). It's very old, and Yafolding does the same thing in a much friendlier manner. But for reasons of historical interest, here's how Selective Display works.

Given a numeric argument of *N*, `C-x $` folds all lines that are indented more than *N* spaces. Suppose your Buffer contains this simple outline-like text[278]:

[278] Of course, to manage an outline like this you'd really use Org Mode and its built-in folding.

```
Folding Text
  Markup-Based Folding
    Outline Mode
    Org Mode
  Implicit Folding
    selective display
    Hide / Show Minor Mode
    3rd-party
      yafolding
```

These lines are indented in steps of two, with the first line not indented at all. So `C-u 1 C-x $` would hide all lines but the first:

```
Folding Text...
```

To unfold and reveal all your text, invoke `C-x $` without any argument.

Line-based motion commands like `C-n`, `C-p`, `<up>`, and `<down>` skip over the folded text, but other commands will move into it, including searching. If you find yourself lost in the folded text, just unfold it.

If you invoke `C-u 3 C-x $` it will hide all the lines with indentation of 3 or more spaces:

```
Folding Text
  Markup-Based Folding...
  Implicit Folding...
```

Having to count the spaces in the indentation is an awkward step. This alternative function automates the process. If you like it, you can use it to replace the standard command with:

```
(keymap-global-set "<remap> <set-selective-display>" 'ue-auto-selective-display)
```

but it's really just a poor man's Yafolding.

```
(defun ue-auto-selective-display (arg)
  "Hide lines with greater indentation than this one.
With a prefix ARG, reveal all lines.

This function simply sets `selective-display'."
  (interactive "P")
  (if arg
      (setq selective-display nil)
    (save-match-data
      (save-excursion
        (forward-line 0)
        (if (looking-at (rx (+ space)))
            (setq selective-display (1+ (length (match-string 0))))
          (setq selective-display 1))))))
```

UNFINISHED *Templates*

International Character Set Support

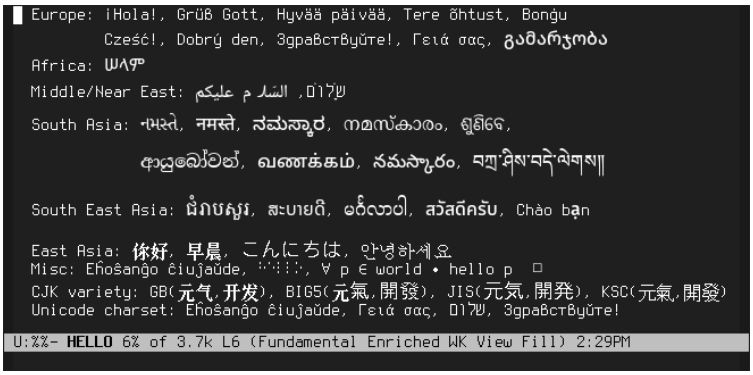


Figure 47: `M-x view-hello-file` (`C-h h`)

Emacs has very sophisticated support for international languages and the character sets and encodings used to represent them. This is one of the more complex Emacs topics: there are 23 pages devoted to it in the manual and I won't attempt to cover all of it here. I'll describe the most useful facilities for a mostly-monolingual Emacs user, from my perspective as an English speaker.

In the earliest days of computing, the only characters you could use were the upper case Latin alphabetics, the base 10 digits, and a handful of punctuation characters. Pretty quickly, non-English speakers and users of non-Latin alphabets, syllabaries, and logographies—various *scripts*—defined their own mutually incompatible character sets, and a Tower of Babel reigned.

You would think that, since the polyglot Unicode is now the standard, with its support for 160-odd historical and modern scripts and over 150,000 characters, symbols, and emojis, there would be no need to handle any other character sets, but in addition to legacy data, Unicode is not yet completely dominant. In particular, users of Chinese, Japanese, Korean, and Cyrillic scripts still use non-Unicode character sets for various reasons. While most text editors support Unicode, they may *only* support Unicode (and sometimes only Unicode's UTF-8 encoding[279]).

Emacs supports 1,071 character sets and encodings, including

[279] Unicode has four or five more encodings, depending on how you count them.

Unicode and ISO-2022 (which allows you to switch between different character sets in a given File). It also handles bidirectional text: that is, you can combine scripts that are written from right to left (like Arabic or Hebrew) with text written from left to right (like English). For a quick demonstration of all this, invoke `C-h h` (`view-hello-file`).

Emacs also supports 251 *input methods*, which are ways of entering characters that might not have keys on your keyboard, including both natural language scripts and various types of symbols (e.g. mathematical). You can see all of them via `M-x list-input-methods`. The Package Manager has 18 additional input methods.

Language Environment

You can enter or view any kind of text in any script in any Buffer at any time. That is, you can have, say, Latin, Cyrillic, Hebrew, and Tamil scripts all mixed together; the buffer popped up by `C-h h` is a perfect example—see Figure 47.

But Emacs always has a notion of your default *language environment*. Normally, your operating system defines this[280] and Emacs inherits it. (If your OS sets it wrong, or you just prefer a different one for Emacs, you can override it; see "Language Environments" in the *Emacs* manual.) Your language environment determines which character sets (Emacs calls them *coding systems*) are assumed as defaults for the files you create and edit, the script used to represent such text (and therefore an appropriate font for that script), and a way of interpreting your keyboard to enter the glyphs that comprise the script.

[280] Your *locale*.

If your OS has declared your correct language environment and you have the necessary fonts installed, everything in Emacs should work out of the box.

You can browse all the language environments with `C-h L` (`describe-language-environment`); here's what you'll see if you choose Czech:

```
Czech language environment

This language environment is almost the same as Latin-2,
but sets the default input method to "czech",
and selects the Czech tutorial.

Sample text:
  Přejeme vám hezký den!

Input methods (default czech)
  czech ("CZ" in mode line)
  czech-prog-3 ("CZ" in mode line)
  czech-prog-2 ("CZ" in mode line)
  czech-prog-1 ("CZ" in mode line)
  czech-qwerty ("CZ" in mode line)

Character sets:
  ascii: ASCII (ISO646 IRV)
  latin-iso8859-2: Right-Hand Part of ISO/IEC 8859/2 (Latin-2): ISO-IR-101

Coding systems:
  iso-8859-2 (‘2’ in mode line):
 ISO 2022 based 8-bit encoding for Latin-2 (MIME:ISO-8859-2).
 (alias: iso-latin-2 iso-8859-2 latin-2)
```

The most practically useful section of this information is the list of *input methods*, which in this case are systematic ways for someone who works primarily in Czech to enter characters from the Czech script.

Inserting the Occasional Funny Character

But first let's discuss the *non-systematic* way to enter characters: that is, characters that aren't a normal part of your spoken language's script, ones that you only occasionally need to type. This includes typographical symbols like the *pilcrow* or *paragraph symbol* ¶, the copyright symbol ©, emojis. and the odd character from some other language with a different script. With no disrespect to natural languages other than your own, I'll call all of these *funny characters*.

The easiest way to insert these characters is with `C-x 8 RET` (`insert-char`), which uses Completion to prompt you for the name of a Unicode character. Usually you can just narrow the enormous list of 45,000-odd candidates by typing words from their official long Unicode name—the word "paragraph" will narrow the list to 10 different paragraph symbols, and you'll see the Pilcrow you want near the elegant Ethiopic Paragraph Separator. If you know the Unicode code-point (a hexadecimal number), you can enter that instead.

The `C-x 8` prefix has a whole slew (close to 200) of other convenient key bindings to insert common funny characters. For example, `C-x 8 C` inserts the copyright symbol; `C-x 8 [` and `C-x 8 ]` insert the left- and right-curly single quotation marks, etc. I don't actually

know any of these and just use `C-x 8 RET` for everything I need (my completion system puts the ones I use regularly at the top of the list). To see the complete list of shortcuts, type `C-x 8 C-h` (or `C-h b` (`describe-bindings`) and search for "C-x 8" in that Buffer).

Inserting Emojis

Emojis are just Unicode characters so you can insert them with `C-x 8 RET` (`insert-char`), but as of v29.1, Emacs has excellent new emoji-specific support.[281] These new commands are all on the `C-x 8 e` prefix.

[281] Thanks to Lars Ingebrigtsen of Gnus fame.

Table 43: Emoji Commands

	Key	Action
Insertion	`C-x 8 e i`	insert an Emoji
	`C-x 8 e e`	... the same
	`C-x 8 e r`	insert a Recently-used emoji
	`C-x 8 e l`	List all emojis by category in a new window
	`C-x 8 e s`	Search for an emoji
Display	`C-x 8 e +`	increase emoji size
	`C-x 8 e -`	decrease emoji size
	`C-x 8 e 0`	reset emoji size
	`C-x 8 e d`	Describe the emoji at Point

`C-x 8 e i` (`command emoji-insert`) displays the emojis grouped by category and lets you insert one with a couple more quick keystrokes; see Figure 48.

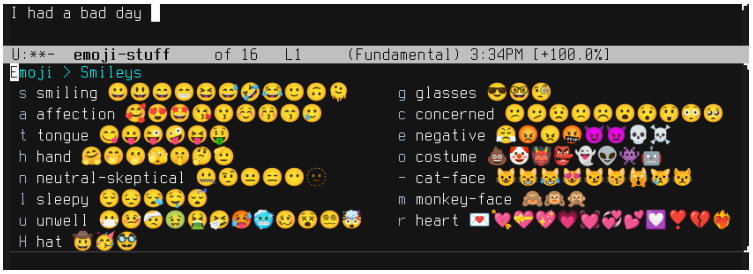


Figure 48: Inserting an Emoji

`C-x 8 e l` (`emoji-list`) is like a high-visibility version, using a popped-up window in which all the emojis are huge—just move Point to the one you want and hit `RET`—and `C-x 8 e r` (`emoji-recent`) is a quicker way to insert an emoji you've used recently.

Rather than inserting an emoji, sometimes you're faced with one from an outside source—perhaps in an email—and you simply can't even tell which emoji it is! This is especially the case at smaller font sizes. Just put Point on that mystery emoji and hit `C-x 8 e +` (`emoji-zoom-increase`); just that emoji will be embiggened, and you can keep hitting `+` until you can recognize it. Finally `C-x 8 e d`

(`emoji-describe`) will tell you the official Unicode name of the emoji at Point, in the Echo Area. This is way nicer than having to google-up the emoji's name.

Input Methods

If you're typing in a language that uses a lot of diacritical marks. like Czech, or a completely non-Latin script, like Ukrainian, you'll be typing `C-x 8` way too much. Instead, you want to use an *input method*. An input method causes Emacs to translate the ordinary ASCII characters of your keyboard into non-ASCII characters.

Broadly, there are two kinds of input methods. One kind remaps all (or many) of your normal keyboard keys, often to match the typical hardware computer keyboard that would be used by the user of a given language; the input method Emacs calls `ukrainian-computer` matches the Ukrainian keyboard in Figure 49.

Figure 49: A Ukrainian Keyboard

So to enter the Ukrainian ϕ character, you would just press the `a` key, and to enter the Ukrainian `E` you press the `T` key.

If Ukrainian is your default language environment, this input method will be your default.

But perhaps you're an English speaker with a default English language environment who also speaks Ukrainian and therefore sometimes types large amounts of Ukrainian text. To solve this problem, you can change the input method associated with a given Buffer with `C-x RET C-\`. After switching away from your default like this, a simple `C-\` will toggle back and forth between the two; use `C-u C-\` to change to yet another input method.

Another use for the broad type of input method is to use a non-standard keyboard layout for your default language environment, like the well-known Dvorak kayboard layout for English, regarded as superior to QWERTY by its partisans. Just do `C-x RET C-\` and specify `english-dvorak`.

The second, less broad, kind of input method only changes a few ASCII characters and treats them as Prefix Keys that you can use to enter funny characters. For example, there are several input methods for entering the characters of the International Phonetic Alphabet

(IPA) used by linguists, and by lexicographers to indicate pronunciation in dictionaries, whereas the `tex` input method changes only a few characters (mostly `\`, `^`, and `$`) into prefixes to enter close to 2,000 funny characters, including many technical and mathematical ones, like `\exists` for ∃ and `\lambda` for λ; you can use `TAB` to complete these.[282]

[282] These mnemonics come from those used in the TEX typesetting system.

I use `latin-1-postfix` as my default transient input method (the one that `C-\` will switch to by default); this makes it easy for me to enter the occasional foreign language[283] proper noun by making all the ASCII characters that are typically accented in Western European Latin-script languages into postfixes.

[283] For me, non-English...

So after enabling `latin-1-postfix` with `C-\`, I can more easily type the French word *déçût*: when I typed "e" Emacs reminded me, in the Echo Area, of the possible stand-ins for accents, displaying: `e["'/^‘]`—I then typed `'`, the pair of which became "é"—and when I typed "c" I saw the reminder `c[,]` and added the comma to get "ç", etc.; see Table 44. Typing an `e` followed by some character *other than* any of the special e-accent stand-ins just gives you a plain `e` followed by that character—so `et` for example comes out as `et`—and if you need to type an `e` followed by one of the stand-ins, you just double the stand-in, so `e^^` gives me `e^` rather than `ê`. It's an easy to learn system, even if you don't use it much.

Keystroke	d	e	'	c	,	u	^	t
Buffer Contents	d	de	dé	déc	déç	déçu	déçû	déçût
Echo Area		e["'/^‘]		c[,]		u["'^‘]		

Table 44: Typing *déçût* with `latin-1-postfix`

Table 45 summarizes some of what the `latin-1-postfix` Input Method can do.

Accent	Postfix	Examples
acute	'	a' → á
grave	‘	a‘ → à
circumflex	^	a^ → â
diaeresis	"	a" → ä
tilde	~	a~ → ã
cedilla	,	c, → ç
nordic	/	d/ → ð ; t/ → þ ; a/ → å ; e/ → æ ; o/ → ø
others	/	s/ → ß ; ?/ → ¿ ; !/ → ¡ ; // → °
	various	« → « ; » → » ; o_ → º ; a_ → ª

Table 45: `latin-1-postix` Input Method Summary

There's also a `latin-1-alt-postfix` Input Method that's only slightly different (thought by some to be more convenient), and a `latin-1-prefix` Method in which you type the activating punctuation mark *before* the letter. There are a couple of dozen more `-prefix` and `-postfix` Input Methods suited to various other combinations of scripts.

Coding Systems

Emacs supports 267 coding systems, but they only really come into play when you read (visit) or write (save) a file, because data in memory is represented in an internal format known only to Emacs; at the transition between Emacs and the file system, Emacs has to translate to or from a coding system.[284]

Emacs can recognize some coding systems automatically when you visit a file, or when you save a file after editing, but some sequences of bytes in text are inherently ambiguous. When this occurs, Emacs will choose based on an order of preference if possible; otherwise you'll be offered a list of compatible coding systems and asked to identify the correct one. When Emacs chooses one for you, you can find out which one it is with `M-x describe-current-coding-system`, and if you disagree, you can change it with `C-x RET r` (`revert-buffer-with-coding-system`).

You can force a persistent specific coding system for a particular file in two ways: via a File-Local Variable or, more broadly, set it according to a file extension. For example, to specify Chinese BIG5 via a File-Local Variable, you could add this line to the top of the file:

```
-*- coding: big5; -*-
```

Or, if all your `.txt` files are in BIG5, you could specify that in the `auto-coding-alist` variable. That variable is flexible enough to specify a coding system for just one file, or all the files in a given directory, regardless of their extension.

[284] Coding systems also come into play at the interface of Emacs and another process, Emacs and a filename, or Emacs and a terminal; see "International" in the *Emacs* manual.

Line Endings

One final wrinkle concerns *line endings*: the way text encodes where lines break. This is independent of the coding system and is indicated by *control characters*. There are three different ways to indicate a line ending:[285]

unix use a control-J (ASCII 10 = #x01 = `^J`) aka *linefeed*

mac use a control-M (ASCII 13 = #x0D = `^M`) aka *carriage return*

dos use a pair of carriage return followed by linefeed (`^M^J`) aka *CRLF*

As the names suggest, these three different line-endings are mandated by the three major families of operating systems. If you are a Windows user and receive a file created by a Macintosh user, you might have trouble distinguishing the breaks between lines because they are encoded differently. How massively annoying!

[285] Thanks, history…

The good news is, the Unix operating systems[286] have mostly won this battle[287]. Apple switched from its carriage return line endings after 2001, when they rewrote the Mac OS operating system and based it on Unix, inheriting the linefeed. So the *unix* category above includes Mac OS X, and the *mac* category only includes old unconverted Classic Mac OS data.

Unfortunately, Microsoft Windows is still sticking to its CRLF line endings (inherited from MS-DOS in 1985), by far the most awkward of the three.

As a result of all this, every one of the 267 coding systems comes in all three flavors of line endings: so there's `utf-8-unix`, `utf-8-mac`, and `utf-8-dos`; also `big5-unix`, `big5-mac`, and `big5-dos`; and so on. You don't usually need to specify the full names of the coding system and can just say `utf-8` and `big5` and the like—they will default to your operating system's line-ending type—and Emacs will typically figure out the line endings automatically when you read in a foreign file. But when you occasionally need to save a file for a Windows user, you can do so by spelling it out explicitly.

[286] Including Linux and the BSDs.

[287] Though not so recently that you will never encounter a file with lines encoded "the wrong way"...

Remote File Editing with Tramp

One of Emacs's killer features is its ability to transparently edit files over the Internet on remote computers via the Tramp subsystem. Instead of logging-in to a remote computer (with `ssh`, say) and firing up Emacs on that computer to edit a file, you just use `C-x C-f` (`find-file`) with special remote-file syntax and edit the file in your local Emacs. This means that Emacs doesn't even need to be installed on the remote computer!

While other editors have added a version of this feature recently, Emacs has been doing this since at least 1989[288]. I believe that Tramp supports more remote file access protocols and features than any other editor.

Every time that Emacs asks you for a filename, you can optionally use Tramp's remote file syntax[289]. So if your username on the host `myoffice.example.com` is `mary`, you might edit your file `~/txt/project.org` on that computer with:

```
C-x C-f /ssh:mary@myoffice.example.com:txt/project.org
```

It will pop up a Buffer called `project.org` and editing will work exactly like editing a local file, at local speeds. You might notice a few messages about the network connection flash past in the Echo Area if you're paying attention, but otherwise it's hard to tell you're editing a remote file. Backup files and auto-save files work as you'd expect. When you save your Buffer in any of the usual ways, your edits are written out to the remote file. You don't have to specially shut-down a network connection: just kill the Buffer whenever you like (or not).

Additionally, you can visit a remote *directory* with `C-x C-f` or `C-x d` (`dired`) and it will of course come up in a Dired buffer! All the normal Dired file management commands work as usual. Pop up another Dired Buffer—either on that remote host, or on your local host, or on a second remote host—and you've got two-panel file management and can easily copy or move files from one host to another.

If you run `M-x pwd` you'll see that this Buffer's working directory

[288] Previously we used the `ange-ftp` package for this; it still exists, but the much more powerful Tramp package has handled remote editing since 1998.

[289] That includes filenames you might put in your Init File.

is `/ssh:mary@myoffice.example.com:txt/`. This has interesting implications. If you visit another file from this Buffer with `C-x C-f` (or anything else) from this Buffer, the default directory will indeed be the remote directory revealed by `pwd`, so it's easy to pull up more remote files; if you *don't* want another remote file. just delete the remote part of the filename in the prompt.

Probably the most amazing feature is that Emacs functions that run external commands, like `M-x grep`, `M-x shell`, `M-x compile`, Dired's `!` (`dired-do-shell-command`) and `&` (`dired-do-async-shell-command`) commands, and the like all run *on the remote host*, due to the `default-directory` being expressed in Tramp syntax. This means all the VC version control commands work remotely too: pull up that remote file, make your edits, diff it against an older version, and check in your changes with the same simple VC commands you use on local files: Tramp makes them run remotely.

Getting Started

Let's see if Tramp works for you out of the box! The full Tramp remote file syntax looks like:

```
/method:user@host#port:/path/to/file
```

Most of these components have default values; see Table 46. The

Table 46: Tramp Filename Syntax

Component	Default	Meaning
method	`scp`	how to connect (protocol)
user	local user	remote user
host		remote hostname
port	standard port	port number for the protocol
path	`~/.`	remote home directory

most commonly used *method* is probably `ssh` or `scp`. If your local username is the same as your remote username, you can skip the *user*@ part of the filename. You can use a relative hostname (e.g. just `myoffice`) if your local host's DNS is set up appropriately (or if you have hostname patterns configured in your SSH configuration). If the remote server is listening on the standard port (e.g. port 22 for `ssh`), you can leave out the #*port* component.

You can also write the *method* as `-` if the method named in `tramp-default-method` (`scp`) is the one you want[290]. Finally, if the `/path/to/file` is in your remote home directory, you can use a relative path (e.g. just `file`). So the shortest remote filename might be: `/-:myoffice:` to pull up Dired on your home directory on `myoffice.example.com`

[290] You can of course Customize what that is.

But let's issue this command:

```
C-x C-f /ssh:mary@myoffice.example.com:newfile
```

Tramp supports completion of most components of a remote file name. If you're using SSH public key encryption and are running `ssh-agent(1)`, there will be no need for you to type your passphrase, but if otherwise, Tramp will prompt you.

You'll know it worked if you get a Buffer named `newfile` and no errors! But to confirm, do `M-x pwd` in this Buffer and make sure the output looks something like:

```
Directory /ssh:myoffice.example.com:/home/mary/
```

Troubleshooting

When both the local and the remote host are running Unix, and you're already set up and happily using SSH for your logins outside of Emacs, Tramp is easy to configure and use. With non-Unix operating systems (like Windows) or less common login protocols (like, say, `telnet` (heaven forbid!)), you may need to do a little light reading. Fortunately, the 5,584-line Tramp manual is very well written, and Tramp maintainer Michael Albinus is one of the most responsive and helpful developers on the help-gnu-emacs mailing list.

In my experience[291], the most common problem encountered in using Tramp is having an *exotic remote shell prompt*. Tramp needs to be able to recognize your shell prompt, and does a pretty good job at it, simply assuming that your prompt ends with one of the characters `#`, `$`, `%`, or `>` followed by a space, which matches the defaults of most shells. If your prompt doesn't fit this requirement, you can fix it by changing the value of `shell-prompt-pattern` (or by changing your shell prompt).

[291] As an `ssh`'ing Unix user...

If you use a fancy multiline shell prompt with right-hand end-of-line components, lots of colors, or perhaps an ASCII-art talking cow, then you may have trouble. This is fixable by hacking your shell's rc file to turn off all the sexiness (only when Tramp is controlling the shell—you can still have your crazy prompt in your interactive shells).

If you're a `zsh(1)` or `bash(1)` user, using *one* of these lines as the *first* line of your `~/.zshrc` or `~/.bashrc` on hosts that you want to Tramp into should do the job:

```
# for tramp
[ ! -n "$INSIDE_EMACS" ] && [[ "$TERM" == "dumb" ]] && unsetopt zle && PS1='$ ' && return # zsh
[ ! -n "$INSIDE_EMACS" ] && [[ "$TERM" == "dumb" ]] &&                  PS1='$ ' && return # bash
```

You can set up your fancy cow prompt after this line and it'll work for you as usual in interactive shells.

For more information and other tips, see "Remote shell setup" in the *Tramp* manual.

Tramp Methods

While the `ssh` method is probably the most commonly used Tramp remote file access method (it is for me), there are actually 39 in total. Ignoring four that are for obsolete and insecure protocols[292] and two for Kerberos users, we can divide the remainder into four main groups: methods for accessing files on Unix systems, methods for accessing local files under different permission schemes, methods for accessing specialized file systems, and methods specific to Microsoft Windows.

Orthogonal to these four classes are two different types of connection: *inline* and *external*.

Inline methods maintain a persistent connection to a remote host, so even if logging in to some remote happens to be slow, after the first connection it will be speedier. These methods are good for frequently editing relatively small remote files, but have relatively high overhead that may slow down access to large files: if you know you're about to visit a large file, you might opt for the equivalent *external* method.[293]

External methods effectively use an additional out-of-band channel to transfer the data (possibly storing the data in a temporary file). These can be slower due to the need to set up and tear down the additional channel, but faster at transferring large amounts of data.

[292] `rsh`, `rcp`, `telnet`, and `nc` (netclient).

[293] Of course you're now wondering, "how large is 'large'?". Unfortunately it depends on the speed of your local computer, your network connection, and your remote computer, so only personal experience will tell.

Unix Remote Access Methods

Unix users accessing remote Unix systems will typically be happy with these three methods.[294]

Method	Type	Comments
ssh	inline	Great for small files
scp	external	Great for large files
rsync	external	Best for large files that already exist on both hosts

[294] Note that for these and other Tramp methods, you'll need to have the prerequisite software (e.g., OpenSSH and `rsync`) installed on both the local and the remote host.

Local Permission Access

Sometimes you need to access a file on your local system as if you were a different user. Tramp makes this situation look like a remote file access.

The most common situation for Unix users on their own desktop machine is the `sudo` method, which lets you access a file or directory as root via the `sudo(8)` program. It also allows you run a root shell in your Emacs by visiting a file or directory as root and then running `M-x shell` within that Buffer.

Since this family of methods run on the local host, you just leave the hostname part of the remote filename empty, e.g. `/sudo::/etc/resolv.conf`.

The `sudoedit` method is a more paranoid version of `sudo` that's more annoying to use.

`su` is similar to `sudo` but uses `su(8)` and allows you to edit as some other non-root user; of course you have to have the ability (i.e., permission) to use `su(8)` outside of Emacs for this to work.

`doas(8)` is an alternative to `sudo` that is the default on OpenBSD systems.

Finally, the `sg` method uses `sg(8)` to let you edit files under a different group.

Method	Type	Comments
sudo	inline	Root access
sudoedit	external	Paranoid root access
su	inline	Access as a different user
doas	inline	... via `doas(8)`
sg	inline	Access as a different group

Specialized File System Access

There are a number of "file systems" that aren't *real* file systems, i.e. aren't simply organizations of bytes on a disk partition. Instead, they're *applications* that offer up files, masquerading as file systems. Tramp can handle several of these. Note that all of them require external programs to be installed, and these are all external methods.

Method	Comments
ftp	For FTP servers
sftp	SSH FTP
rclone	Many remote storage systems via `rclone(1)`
sshfs	Remote files via the sshfs file system
afp	Apple Filing Protocol
dav	WebDAV
davs	... via SSL
gdrive	Google Drive
nextcloud	NextCloud and OwnCloud systems
mtp	Media devices like phones and cameras
adb	Access a phone through the Android Debug Bridge

Windows-Specific Access Methods

Microsoft Windows does things its own way. If you're a Unix Emacs user that needs to access files on a remote Windows machine, probably all you'll need is the `smb` method. If you're a Windows Emacs

user that needs to access remote hosts, whether remote Unix or remote Windows hosts, you may need to use the other methods depending on how your Window system is set up.

Method	Type	Comments
smb	external	Access files via Samba or SMB
sshx	inline	see note
scpx	inline	see note
plink	inline	... via Putty
plinkx	inline	... see note
pscp	external	... via Putty
psftp	external	... via Putty

The Tramp manual says that the methods with a trailing "x" are useful for MS Windows users when the standard methods trigger an error about allocating a pseudo TTY, and sure enough I need to use `sshx` on the one Windows machine I occasionally use in a meeting room at work.

Frankly, as someone who's basically never used MS Windows, I can't pretend to understand these distinctions. As always, see the manual.

Third-Party Tramp Methods

There are several additional Tramp methods available as third-party packages, mainly for containers like docker, podman, kubernetes, lxc, hdfs, nspawn, and vagrant.

Multi-Hop Connections

Perhaps you're at home and need to access a file on work machine `internal.example.com` that's on a non-routable private network, like a host with `10.*.*.*` IP address. This would normally be impossible, but if this host is accessible via ssh from your work desktop `myoffice.example.com`, say, then you can use that as a proxy. You can Tramp into the internal host via a *multi-hop* filename like this: `/ssh:myoffice.example.com|ssh:internal.example.com:/filename`. You just separate the hops with vertical bars (`|`). You can mix different methods (e.g. `ssh` to get to the proxy, but `smb` to get to the internal host) and different usernames for each hop.

This implies that you can edit a file on `myoffice.example.com` as root by adding a `sudo` hop at the end (`/ssh:myoffice.example.com|sudo::/filename`) and indeed that works fine. Very powerful.

Note that some methods can't be used in multi-hop pathnames, e.g. `scp`; I suspect that external methods are the ones that don't work.

At any rate, Tramp will tell you if you try an unacceptable combination.

Connection Cleanup

Occasionally you may find that your persistent Tramp connections are hung. This is most likely to happen if a network connection gets dropped—say, your WIFI connection gets dropped, or the remote host is rebooted, or you slept your laptop. In some cases Tramp automatically reconnects for you and you don't even notice, but if you're getting Tramp errors, you can fix them by cleaning up your connection and starting over.

The first command to try is `M-x tramp-cleanup-connection`, which will offer all your remote connections for completion. Pick the one that's generating complaints, and now you can reconnect to that host (say by revisiting the file with `C-x C-v` (`find-alternate-file`) or `M-x revert-buffer`. If you just like to keep things neat, you can explicitly clean up connections when you know you're done with them.

In extreme cases, you can use `M-x tramp-cleanup-all-buffers` to clean up all your connections for a totally fresh start. See "Cleanup remote connections" in the *Tramp* manual for more information.

References

Free Software Foundation. 2022. *TRAMP User Manual.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET tramp RET`.

Client / Server

In this book I advocate living in Emacs the Lisp Machine: using pure Elisp applications (like Calc for your calculator, EWW for your web browser, and Dired for your file manager) and Emacs front-ends to the external applications you need to use (like VC for your version control and Ediff for your diffing and merging), But even if you work this way as much as possible, you'll inevitably need to occasionally run an application from a shell in a (non-Emacs) terminal, and some of these applications will want to invoke "your editor". For example, if you use `mutt(1)` as your mailer[295], it will need to invoke your editor every time you compose an email; if you run `git(1)` in the terminal for version control[296] it will invoke your editor so you can edit a commit message.

[295] Instead of using Emacs as your mailer...

[296] Instead of using Emacs VC or Magit...

Programs like this typically determine your preferred editor via the value of the `EDITOR` environment variable. Yes, you can set `EDITOR=emacs`, but this isn't really right: Emacs is already running, and has been running since you booted your computer, right? Every additional time Emacs is fired up, you're divorced from all the files, Buffers, and everything else in your main Emacs instance: your *state*. Also, any `vim(1)` user will tell you that Emacs takes too long to start up (this isn't really true, but a large and insufficiently lazy Init File can make it so).

The solution to both of these problems—speed, and isolation from your state—is to run the *Server* in your main Emacs instance, and set your `EDITOR` to be `emacsclient`.

`emacsclient(1)` is a separate program that installs alongside `emacs(1)`. When you run it, all it does is instantly connect to your running Server, where all your state is, creating a new Buffer editing the file that was named on the `emacsclient` command line. When you're done editing this file, you have Emacs tell the `emacsclient` that you're done, and the Client then terminates.

And speaking of state, when you're in an `emacsclient` Buffer, you really *are* in the Server Emacs: all your state is available: you can switch Buffers, split Windows, edit other files or read some emails: anything you like. If you've jumped around and have forgotten

where your new client Buffer is, you can invoke `C-x #` (`server-edit`) and it will take you back there.

A program like `mutt` or `git` will have invoked `emacsclient` with the name of a temporary file where you'll edit your email or `git` commit message: this file gets visited in your Server Emacs like any other file. The external program will be waiting for you to finish editing before it mails the email or checks-in the commit message.

When you're done with the edit, you'll save the Buffer as usual, and then invoke `C-x #`. When you invoke this command in a client Buffer, it tells `emacsclient` that you're "done" with this edit: it kills the Buffer containing the temporary file, and terminates, returning control to the program that invoked `$EDITOR`. Note that only the `emacsclient` program, *not* your Emacs Server, terminates: the Server keeps running, preserving all your state.

A subtlety for Unix users, at least: `C-x #` tells the `emacsclient` to exit *successfully* (i.e. with a status of zero); on rare occasions you might want to tell it explicitly to exit *unsuccessfully* (i.e. with a non-zero status) so that the program that invoked the Client via `$EDITOR` knows you're unhappy with your edit. So `mutt` for example would *not* send your email[297], and `git` would abort your commit. You can do this by invoking, instead of `C-x #`, `M-x server-edit-abort`.

[297] I would hope...

If your Emacs Server and your terminal are side by side when the external program invokes `emacsclient`, you'll see the temporary file suddenly appear in Emacs. If your Emacs is not visible—because it's on another desktop, or it's iconified (minimized) or buried under a pile of other windows—you'll have to pull it up to do your editing. You can instead arrange for the `emacsclient` to open up a new Frame right in front of you; see below.

It's not only programs using `$EDITOR` that can invoke `emacsclient`—you can invoke it explicitly yourself.[298] Invoking it with a filename, say:

[298] See *Edit, Compile, Run Cycle.*

```
emacsclient foo.c
```

will visit `foo.c` in the Server. This time it's your shell that's waiting for `emacsclient` to terminate. You'll notice that, in your shell, `emacsclient` has printed a message and your shell is waiting for it, and hasn't yet displayed its next prompt:

```
$ emacsclient foo.c
Waiting for Emacs...
```

`C-x #` will indicate you're finished and you'll get your shell prompt back.

If, in your shell, you invoke `emacsclient` with several filenames, then the Client loads all the files into the Server, and `C-x #` in one of

those Buffers will kill the Buffer and switch to the next file, which has its own Client Buffer. When you've indicated you're done with all the Client Buffers by invoking `C-x #` in each, the `emacsclient` terminates and returns control to the shell. You can edit all these files in any order you like and flip back and forth between them at will.

`emacsclient` Operating Modes

`emacsclient` actually has three distinct modes of operation. The default, as I've described, is to visit a file in an existing Frame of the Server Emacs.

If you use the `-c` or `--create-frame` option, it will instead open a new graphical Frame managed by your window system, exactly as if you had invoked `C-x 5 f` (`find-file-other-frame`) from inside Emacs. This means you don't have to navigate to one of your other Frames that's possibly in another desktop or on another monitor. (This is the option I usually prefer.)

The third possibility is to use the `-t` (equivalently, the `--tty` or `-nw`) option, which will open a new non-graphical Frame right in your terminal. This has the advantage of being most intimately connected to the terminal you're working in, but all the disadvantages of a non-graphical Emacs.

There are several other `emacsclient` options, but most of them are for people with very special needs. Table 47 lists the only ones I've ever needed. The `-n` option tells `emacsclient` not to wait for you to

Table 47: `emacsclient` Options

Option	= Long Option	Effect
`-c`	`--create-frame`	Create a new graphical frame
`-r`	`--reuse-frame`	Reuse an existing frame, otherwise create one
`-t`	`--tty`	create a new Terminal frame
`-nw`	`--tty`	... the same ("No Window")
`-n`	`--no-wait`	No wait for `C-x #`
`-a`	`--alternate-editor`	what to run if no server

"finish editing". It just visits the named file in the Server and you can take all the time you want editing it. This is an *asynchronous* edit, unlike the default `emacsclient` *synchronous* edit, which leaves the invoking shell or other program waiting for you to finish. With `-n`, you get your shell prompt back immediately. It works in all three operating modes: you can combine it with `-c`, `-t`, or neither. Note that you *never* want to include this option in your `EDITOR` environment variable! It would violate the expectations of `mutt`, `git` and friends.

The `-a` option says what to do if there's no Emacs server running; it takes the name of an alternate editor program as a parameter. The best alternate editor is of a course a non-Server Emacs! So this

command:

```
emacsclient -a emacs foo.c
```

edits `foo.c` in the running Server, but if there *is* no running Server, edits `foo.c` in a fresh Emacs.

I recommend configuring your `EDITOR` variable in one these forms, depending on your preference for a graphical client Frame, a non-graphical (terminal) client Frame, or no new frame (the default). I use Posix syntax, which will work for `bash(1)`, `zsh(1)`, etc, but maybe not in exotic shells. This line would go in your `~/.bashrc`, `~/.zshrc`, or equivalent.

Graphical Frame	`export EDITOR="emacsclient -a emacs -c"`
Terminal Frame	`export EDITOR="emacsclient -a emacs -t"`
Existing Frame	`export EDITOR="emacsclient -a emacs"`

With `-c` (or `-t`) you can fire up `emacsclient` without giving it a file name. Maybe you're working in a terminal and want to jot down a quick note in a file that's already in your Server Emacs; `emacsclient -c` will open a new client Frame right in front of you; now, you can switch to the Buffer of interest, and when you're done, delete the Frame with `C-x 5 0`.[299] Or leave the Frame open for as long as you like.

[299] You can't use `C-x #` because, since you gave no filename, `emacsclient` isn't waiting for you to finish.

Edit, Compile, Run Cycle

If you haven't yet completely bought into the new Lisp Machine cult into which I'm trying to recruit you, you may still be spending a lot of time in a terminal shell.

`emacsclient` presents a synchronous mode of editing that allows you to work in the terminal like a `vim` user: compile your program, run `emacsclient` to fix your code, exit and re-compile.

This is an alternative to doing things the Emacs way, in which, instead of living in a shell in a terminal, you're in your Emacs: you pull up your file with `C-x C-f foo.c`, compile it with `M-x compile`, and jump to your errors with `C-x ` (`next-error`). In my opinion, the Emacs way is superior, but if I haven't convinced you, Emacs gives you options.

Remote Server

Another reason to run the Emacs Server is so you can connect to a remote Emacs running on another computer. This is sort of an alternative to using Tramp to edit a remote file in your local Emacs:

you can instead connect to the Emacs Server that you're running on the remote host, and do your editing there.

Tramp is much lighter-weight and is the way to go if you just want to edit a given file, especially over a slow, low-bandwidth, or unreliable network connection. But if what you want is access to your complete remote Emacs *state*, then you want a remote Server connection. The more state you have in the remote Emacs, the more useful this is. When you connect to the remote Emacs you have all your Buffers available: all your web browser tabs, your Registers and Bookmarks, your email, your Dired Buffers complete with all their marks, and all the rest.

It's like a plain-text version of Remote Desktop or VNC on a Windows or Mac OS machine, except in my experience it's *much* more responsive, simply because you're only shipping compact plain text across the network most of the time, rather than high resolution images of GUI windows.[300]

I use this method to connect to the always-running Emacs on my work desktop from my home laptop[301]; this is how I occasionally work remotely, and during the pandemic of 2020 I worked this way exclusively for years. I do all my email in Emacs on my work desktop, and I'm connected to all the work servers via Tramp from this Emacs.

There's really nothing new to learn about using a remote Server: all you do is run the `emacsclient` on the remote host via SSH like this:

```
ssh -f myoffice.example.com emacsclient -c
```

If you're running the X Windows System on a Unix system and you have enabled SSH to use X Forwarding, this will open a new graphical Frame on your local computer, but the Frame belongs to the remote Server running on `myoffice.example.com` and makes all your state available. Simple as that.

If you don't have X Forwarding enabled (you could enable it on the command line with the `ssh -XY` options), use this form of the command:

```
ssh -t myoffice.example.com emacsclient -t
```

The two `-t` options give you a terminal Frame instead. If you have a terrible network connection, the terminal version may be more responsive; I've used this to good effect on long-distance trains for example, which have typically had very sketchy connectivity. Using `mosh(1)` instead of SSH will make for the most robust connection for a non-GUI `emacsclient`.

You do want to have a few SSH options in your SSH config for best results. I use:

[300] N.B. if you have images or PDFs in the remote Emacs, they'll work fine too.

[301] Which is always running its own local Emacs with its own Server.

```
ForwardX11 yes
ForwardX11Trusted yes
ForwardAgent yes
Compression yes
ServerAliveInterval 120
```

Be sure to put these settings at the beginning of your config file. `ForwardX11 yes` is equivalent to `-X` and `ForwardX11Trusted yes` to `-Y`. Without *both* of these options, your GUI `emacsclient` may be very slow at updating the display.

Starting Up the Server

We've talked a lot about the Emacs Client, but how do you start up the Emacs Server? There are at least three ways.

The `--daemon` Option

Start your Server by invoking Emacs with the `--daemon` option. Usually you arrange for this to happen automatically when you start up your computer: for Unix users running the X Window System, this typically means adding the line:

```
emacs --daemon
```

to your `~/.xession` or `~/.xinitrc` file.

When you start up Emacs this way, the usual initial Frame with its splash screen won't appear. You'll need to use the `emacsclient` command to connect to the Server and open up a Frame. If you always want an initial Frame to appear first thing, you can add an invocation of `emacsclient -c` in your `~/.xsession`:

```
emacs --daemon && emacsclient -n -c
```

Have the OS Start the Server

If you're on a Unix OS that runs Systemd, you can have it start up your Emacs Server for you when you log in. The main advantage of this is that Systemd will restart your Emacs if it gets killed. See "Emacs Server" in the *Emacs* manual.

Start the Daemon in Your Init File

You can instead start up the Server from your Init File. This means that whenever you fire up an Emacs, it will ensure that the Server is started for you. This is the method I use. This Init File snippet starts up the Server unless one is already running.[302]

[302] It's possible but unconventional to run multiple servers on the same machine. See "Emacs Server" in the *Emacs* manual.

```
(require 'server)
(if (fboundp 'server-running-p)         ; new in v28
    (unless (server-running-p)
      (server-start))
  ;; server-start will fail if the server is already running...
  (ignore-errors (server-start)))
```

Note that if you're not a regular user of the Server, you can also fire it up interactively on special occasions with `M-x server-start`.

Shutting Down the Server

There's no reason in normal use to explicitly shut down the Server; just let it run until you're done with Emacsing.[303]

[303] You *can* force a shutdown with `M-x server-force-delete` if you really want to.

But the usual command for exiting Emacs, `C-x C-c` (`save-buffers-kill-terminal`), is a little more subtle when you're running the Server. If you give that command in a Client Frame (as created by `emacsclient -c` or `emacsclient -t`), it doesn't exit your Emacs: rather, it offers to save your Buffers and then acts exactly like `C-x #`, informing the `emacsclient` that you're done editing, and then terminating the Client, leaving the Server running. You can use this instead of `C-x #` if you like, though I think developing the `C-x #` habit is better.

If you start Emacs with `(server-start)` and are in the original server Frame (not in a Client Frame), `C-x C-c` *will* exit your Emacs, though in addition to the usual cautions, if there are any attached Clients, you'll be asked:

```
This Emacs session has clients; exit anyway? (yes or no)
```

Note that if you start Emacs with `--daemon`, then *all* Frames are client Frames, so `C-x C-c` will never terminate your Emacs! With `--daemon`, you need to use `M-x save-buffers-kill-emacs` to do so.

Troubleshooting

A quick way to see if your local Emacs Server is happy is to run this command in a shell:

```
emacsclient --eval "(print :ok)"
```

If you get a ":ok" in response, the Server is running and all is well.

You can check on a remote Server by `ssh`'ing to the remote host and running the same command there. Due to shell quoting issues, this obvious shortcut won't work:

Incorrect!

```
ssh myoffice.example.com emacsclient --eval "(print :ok)"
```

You need an extra level of shell quoting:

```
ssh myoffice.example.com emacsclient --eval '"(print :ok)"'
```

In either case, if the Server's not running, you'll get some message like:

```
emacsclient: can't find socket; have you started the server?
```

Very occasionally, you might try to initiate a connection to a remote server and find that `emacsclient` just hangs! Before you do anything as extreme as `ssh myoffice.example.com pkill emacs`, try this command:

```
ssh myoffice.example.com emacsclient --eval '"(top-level)"'
```

Occasionally you'll have left your remote Emacs in the middle of waiting for you to type a response in the Minibuffer or the like, which can cause your `emacsclient` connection to hang; invoking `top-level` can abort this.

Midnight Mode

When you're running the Server, you tend to have a very long-running Emacs, which can accumulate a lot of Buffers.[304] (You can say `M-x emacs-uptime` to see how long your Emacs has been running.) Assuming you're not out of space from visiting enormous files and never killing their Buffers, there's nothing wrong with this per se. However, you might consider 100 or more old Buffers to be too much clutter in your Buffer Menu or your Completion candidates. If so, `midnight-mode` to the rescue. If you invoke it in your Init File:

```
(midnight-mode +1)
```

then every night at midnight, it kills all the Buffers that are more than three days old (for file-visiting Buffers, only if they are unmodified of course). Three days is just the default, and there are a number of exceptions. You can readily exclude Buffers that you never want it to clean up, and force it to always kill Buffers that annoy you. It's very customizable, so if you use it, be sure to investigate it by invoking `M-x customize-group RET midnight`.

[304] If you live in Emacs the way I recommend, this can happen even if you *don't* run the Server.

Ubiquitous Capture & Note Taking

For all Emacs users, one of the most important tasks must surely be *note taking*. Note-taking styles are very idiosyncratic, and there are 49 or so third-party packages designed for note-taking, from simple editing modes, through interfaces to web-based "note services", to complex Zettelkasten implementations, and the awesomeness of Emacs's own all-powerful Org Mode.

But regardless of how you edit, organize, and search your notes, your primary task is to actually *take* them without getting distracted from the task at hand. An idea occurs to you, possibly *completely* unrelated to your current task, and you need to just quickly make a note of it, to be organized—fleshed out, tagged, categorized, linked or whatever is your process—*later*, so that you can get back to your current task with minimal distraction.

This is called *ubiquitous capture* by some: *ubiquitous* because you might take any note anywhere and anytime, and *capture* meaning a bare-bones jotting-down.

Emacs has two main subsystems for ubiquitous capture, which you might combine.

Remember

Remember is the simplest Emacs subsystem for ubiquitous capture. When an idea occurs to you, just say `M-x remember`, and type a line or three in the `*Remember*` buffer that pops up, and then issue the (nearly) universal Emacs "I'm finished with that" keystroke, `C-c C-c` (`remember-finalize`).

That's it! You're back at whatever you were doing when the idea occurred to you, your note has been safely socked away, and you can pull it up later to organize it, flesh it out, etc. The `*Remember*` Buffer is in `remember-mode`, but that Major Mode only has one other command: `C-c C-k` (`remember-destroy`), which lets you abort your note-taking if you've decided you really don't have much of an idea after all.

But where did your note go? The default destination is just to

append it to the file `notes` in your `user-emacs-directory`—on Unix systems, that defaults to `~/.emacs.d/notes`. Wherever it is, you can pull up that file with `M-x remember-notes`.

Each time you capture a new note, it's appended to the end of the file with some metadata and an annotation. Here's what a note might look like:

```
** Tue Feb 14 16:10:56 2023 (new emacs command)
new emacs command
it needs to do something cool!

~/src/tint/lib/types.ml
```

I didn't type the filename at the bottom; `remember` added that for me: it's the name of the file I was editing when I took the note. This can be very useful, and you can easily jump back to that location via `M-x ffap` (see Find File at Point). But if your idea is unrelated to your location, you can just delete that line, as I will do in this case.

The first line of your note (I typed "new emacs command") is automatically prefixed with a timestamp, and the two leading asterisks are the syntax for a new *subheading* in Org Mode, which would be a good candidate for the Buffer's Major Mode. You can Customize `remember-notes-initial-major-mode` to make this so.

I recommend adding a level-1 headline before your new note, so your `notes` file looks something like this:

```
* INCOMING
** Tue Feb 14 16:10:56 2023 (new emacs command)
new emacs command
it needs to do something cool!
```

Since `M-x remember` always appends a note with a level-2 headline, all new notes end up under the `INCOMING` category, as a reminder that you want to file them elsewhere in fleshed-out form, perhaps just in the same file but under some preceding level-1 headline; the result of that might look like:

```
* EMACS IDEAS
** Tue Feb 14 16:10:56 2023 (new emacs command)
Add to dired-mode; needs a good key binding...
(defun my-dired-jump-to-dir-of-file ()
  "Jump to directory of symlink target at point."
  (interactive)
  (dired (file-name-directory (file-truename (dired-get-filename)))))
* INCOMING
```

Other Entry Points

If you give `M-x remember` a Prefix Arg, it will insert the contents of the Region in the `*Remember*` Buffer for you. You can instead use `M-x remember-clipboard` to insert the contents of the system clipboard as the initial contents; this is great for saving things from an external web browser or other non-Emacs application.

You may want to bind `remember` to a key; I use `C-c r` myself.

```
(keymap-global-set "C-c r" 'remember)
```

This extremely simple note-taking system—just one easily accessible file in Org Mode format—may be all you require. But if you need something more, Remember can still serve as your ubiquitous-capture front-end to a more complex system. You can also store notes in multiple files named with a timestamp (so you can have separate files for each day, or week, month, or year); add entries to your Diary when you take a note; or store notes as Email messages (some people like to use an Emacs email client to manage their notes); see "Backends" in the *Remember* manual.

org-capture

The main alternative to the Remember subsystem is *Org Capture* (see "Capture" in the *Org* manual), which fully integrates the Remember workflow into Org Mode. In addition to just providing direct access to all of Org's powerful facilities[305] in your notes (especially easy refiling), it supports an extremely useful templating system that lets you choose, with a keystroke, a location for a given type of note and distinct initial formats and annotation types for each.

If you're ready to make the life-altering deep dive into Org Mode, I highly recommend using Org Capture for your ubiquitous capture needs.

[305] Such as rich markup, hyperlinks, attachments. tagging, TODOs, agendas, etc. . .

Org Mode

> Sitting on top of Emacs is Org mode. It is the thing which made irrelevant my search for the perfect task management software. Like Emacs, you can mold it into whatever workflow works best for you at the time. Later, I discovered it is also a wonderful publishing platform [...]. I have used it to author countless technical specifications, my blog, and all of my books. In "Concurrency in Go", it allowed me to execute the code snippets embedded in the book—a form of literate programming. This ensured that the code people are reading, the output from that code, and the code exported into the book's repository all have the same provenance. — Katherine Cox-Buday / writer, computer scientist

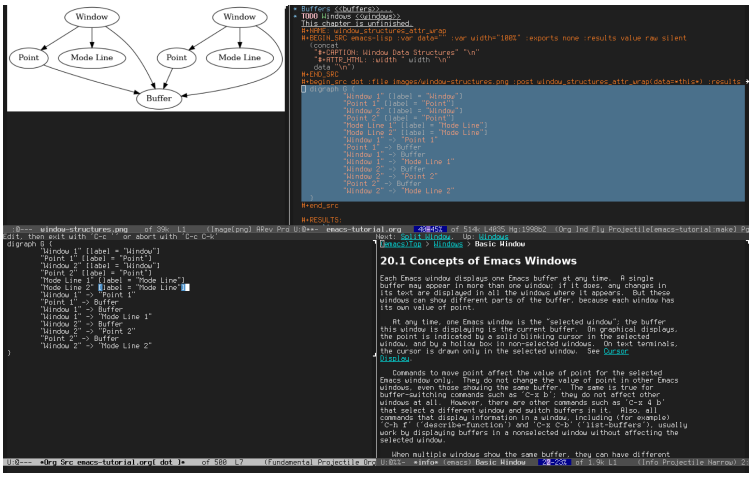


Figure 50: Editing This Book in Org Mode with Babel

Org Mode began with Outline Mode, a simple Major Mode for editing outlines with nested headings, which had been in GNU Emacs since the very beginning. Carsten Dominik wanted something more:

> Org was born in 2003, out of frustration over the user interface of the Emacs Outline mode. I was trying to organize my notes and projects, and using Emacs seemed to be the natural way to go. However, having to remember eleven different commands with two or three keys per command, only to hide and show parts of the outline tree, that seemed entirely unacceptable to me. Also, when using outlines to take notes, I

> constantly wanted to restructure the tree, organizing it parallel to my thoughts and plans.

So he fixed that problem; but soon he started adding more features to it:

> As this environment became comfortable for project planning, the next step was adding TODO entries, basic timestamps, and table support. These areas highlighted the two main goals that Org still has today: to be a new, outline-based, plain text mode with innovative and intuitive editing features, and to incorporate project planning functionality directly into a notes file.

`org-mode` is like a next-generation `outline-mode`. Starting from `outline-mode`'s simple syntax, it adds metadata (such as a notion of author and title), markup (italics, bold, tables), hypertext links, and the ability to export your text as HTML, PDF, and more.[306] It's very easy to use at this level and should be your choice for most of your "plain text" files.

[306] This book is an Org Mode document.

But this description doesn't come close to doing Org justice: Org is the subject of a 24,127-line manual and also incorporates calendaring, agendas, database, spreadsheets, literate programming, and metaprogramming.

While Org is huge and complex and deserving of its own book as big as this one, it's actually extremely easy to use as a better `text-mode` or `outline-mode`, as a better and more Emacs-native Markdown,[307] and to mix in extra features as you feel the need for them. Next thing you know, you can call yourself an Org user.

[307] And you can always export Org to Markdown if you need to talk to outsiders.

So all I'm going to try to do in this chapter is give an introduction to the basic Org rich markup language and how to publish simple documents, and then provide an orientation and summary of the other major Org facilities and how to find out more about them.

Org as a Simple Outliner

Headings begin with a sequence of asterisks: one asterisk is a top-level heading, two is a subheading, and so on. More asterisks marks a heading as being *more deeply-nested* (i.e., on a *lower level*), and so we have a tree structure (imagine paragraphs of text after each of the headings):

```
* Folding Text
This chapter is about folding text.
** Markup-Based Folding
*** Outline Mode
*** Org Mode
** Implicit Folding
```

```
*** Selective Display
*** Hide / Show Minor Mode
*** 3rd-Party
**** yafolding
```

Org calls these heading lines *headlines*. Both lower-level headlines and non-headline text following a headline[308] belong to that headline. Since `* Folding Text` in the above example is the highest-level headline, *everything* after it (up to the next level-1 headline, if any) belongs to it. `** Markup-Based Folding` contains the next two lower-level headlines, but *not* `** Implicit Folding`, which is on the same level.

[308] Like "This chapter is about folding text."

In Org Mode, hitting `TAB` (`org-cycle`) on the first line will fold all the text belonging to it, leaving (in this case) just one visible line:

```
* Folding Text...
```

Note the ellipsis at the end of the line, which indicates the presence of hidden folded text under this headline (the dots are just for display and are not actually actually added to your text).

Another `TAB` will reveal all the next lower level headlines and any contained text:

```
* Folding Text
This chapter is about folding text.
** Markup-Based Folding...
** Implicit Folding...
```

You can see that the level-2 headlines remain folded.

A third `TAB` unfolds everything underneath. Finally, a fourth `TAB` will fold everything under `* Folding Text` again, starting the cycle over. You can fold and unfold starting on any headline, not just at the highest level.

As with all the Emacs text folding subsystems, the invisible text is still there: you can search into it, and if you copy a Region containing the folded text, the copied text contains all the folded text as well; if you save the Buffer when it's folded, you are of course saving all the folded text as well (the next time you open the file, all your text will be there, unfolded).

The tripartite cycling of `TAB` has a *global* (i.e. whole Buffer) counterpart in `S-TAB` (`org-shifttab`), which does the same three levels of unfolding and folding but applied to *all* the headlines in the Buffer simultaneously. So the book you're reading, which is a single 22,862-line Org Mode document, can be folded with one `S-TAB` to fit completely in half a screen of my Emacs Window.

See "Headlines" in the *Org* manual and "Visibility Cycling" in the *Org* manual for more information.

Org's Rich Markup

There are a number of *lightweight markup languages* designed as so-called *humane* alternatives to heavyweight markup languages like XML, HTML, TEX and LATEX, and Troff: they are easier to learn and easier to type, and more readable—that is, the markup is meant to be suggestive of a typeset equivalent.

Org's markup language is comparable to others such as Markdown, reStructuredText, or AsciiDoc, but I would claim it's more powerful—especially for an Emacs user. Let's take a look at Org markup side-by-side with the published result, keeping in mind that there's more[309] to many of these constructs.

[309] A *lot* more in the case of, for example, the spreadsheet...

The headlines demonstrated above are part of Org's markup, and much of the text between the headlines can be thought of as paragraphs, simply separated from each other by blank lines. Within the text, there are a number of ways of indicating emphasis:

```
Emphasis is indicated like so: /italic/,
*bold*, _underlined_, =verbatim=,
~code~, and +strike-through+; other
markup syntax is ignored in verbatim and
code text, and is typically published in
a monospaced font.  You can escape a
markup syntax character by preceding it
with a leading Unicode zero-width space
(codepoint 200B).
```

Emphasis is indicated like so: *italic*, **bold**, underlined, `verbatim`, `code`, and ~~strike-through~~; other markup syntax is ignored in verbatim and code text, and is typically published in a monospaced font. You can escape a markup syntax character by preceding it with a leading Unicode zero-width space (codepoint 200B).

```
A horizontal rule, spanning a published
page, is a line with 5 or more hyphens:
-----
```

A horizontal rule, spanning a published page, is a line with 5 or more hyphens:

```
Subscripts are indicated with an
underscore, as in H_2O, and superscripts
with a caret, as in 5^2 = 25.  -- is an
en-dash and --- an em-dash.  Org
supports over 400 named "entities" that
provide a convenient way to enter
special symbols like \lambda and
\exists.
```

Subscripts are indicated with an underscore, as in H_2O, and superscripts with a caret, as in $5^2 = 25$. – is an en-dash and — an em-dash. Org supports over 400 named "entities" that provide a convenient way to enter special symbols like λ and $\exists$.

```
There are several large-scale
structures.  A simple unnumbered list
looks like this:
- tables
- verse
- quote
- centered
- example

A keystroke can convert it to a numbered
list in various formats; =org-mode= will
recompute the numbering for you if you
move, delete, or add items.
```

There are several large-scale structures. A simple unnumbered list looks like this:

- tables
- verse
- quote
- centered
- example

A keystroke can convert it to a numbered list in various formats; `org-mode` will recompute the numbering for you if you move, delete, or add items.

```
A block quote looks like:
#+begin_quote
As we enjoy great Advantages from the
Inventions of others we should be
glad of an Opportunity to serve
others by any Invention of ours, and
this we should do freely and
generously. --- Benjamin Franklin
#+end_quote
```

A block quote looks like:

> As we enjoy great Advantages from the Inventions of others we should be glad of an Opportunity to serve others by any Invention of ours, and this we should do freely and generously. — Benjamin Franklin

```
and verse (or just anything where you
want unfilled lines) looks like this:
#+begin_verse
We shall have to evolve
problem solvers galore
since each problem we solve
creates ten problems more.
--- Piet Hein
#+end_verse
```

and verse (or just anything where you want unfilled lines) looks like this:

> We shall have to evolve
> problem solvers galore
> since each problem we solve
> creates ten problems more.
> — Piet Hein

```
Literal examples in which markup doesn't
apply can be done like this:
#+begin_example
Athens -> Piraeus
London -> Thamesport
#+end_example
Example blocks are published in a
monospace font.  Short one-line examples
can be done this way:
: Rome -> Civitavecchia
```

Literal examples in which markup doesn't apply can be done like this:

```
Athens -> Piraeus
London -> Thamesport
```

Example blocks are published in a monospace font. Short one-line examples can be done this way:

```
Rome -> Civitavecchia
```

```
Source code blocks can be used for any
programming or markup language Emacs
knows about:
#+begin_src emacs-lisp
  (with-demoted-errors "%s"
    (add-to-list
     'default-frame-alist
     '(font . "Helvetica 12")))
#+end_src
These blocks can be colorized in your
Org Mode Buffer, and also when
published.  They can also be evaluated
and used for metaprogramming and
literate programming.
```

Source code blocks can be used for any programming or markup language Emacs knows about:

```
(with-demoted-errors "%s"
  (add-to-list
   'default-frame-alist
   '(font . "Helvetica 12")))
```

These blocks can be colorized in your Org Mode Buffer, and also when published. They can also be evaluated and used for metaprogramming and literate programming.

```
Org supports hyperlinks that are
"clickable" in your Org Buffer and are
rendered as links when you publish your
document.  Simple URLs display as
themselves --- https://www.gnu.org/ ---
or you can wrap them in
[[https://www.gnu.org/][a description]].
Internal links allow you
jump between places in your document,
and many specialized Emacs-only link
types are supported (you can link to
email messages, attachments, Info docs, manual
pages, etc).
```

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```
Org has phenomenal support for tables
(including spreadsheets embedded in
your document); this easy-to-type table:
| Language | Files
|-
| OCaml | 2175
| Emacs Lisp | 156
| Tcl | 13616
when published will look beautiful,
and a keystroke in your Org Buffer
(totally optional) will align the
columns for easy reading while you edit:
| Language   | Files |
|------------+-------|
| OCaml      |  2175 |
| Emacs Lisp |   156 |
| Tcl        | 13616 |
```

Org has phenomenal support for tables (including spreadsheets embedded in your document); this easy-to-type table:

Language	Files
OCaml	2175
Emacs Lisp	156
Tcl	13616

when published will look beautiful, and a keystroke in your Org Buffer (totally optional) will align the columns for easy reading while you edit:

Language	Files
OCaml	2175
Emacs Lisp	156
Tcl	13616

```
I can sum up the files column using the
spreadsheet (I never typed the 15947):
| Language   | Files |
|------------+-------|
| OCaml      |  2175 |
| Emacs Lisp |   156 |
| Tcl        | 13616 |
|------------+-------|
|            | 15947 |
#+TBLFM: @5$2=vsum(@I..@II)
A simple =C-u C-c C-c= anywhere in the
table will update all formulas; the
formulas will also be re-computed upon
publication.
```

I can sum up the files column using the spreadsheet (I never typed the 15947):

Language	Files
OCaml	2175
Emacs Lisp	156
Tcl	13616
	15947

A simple `C-u C-c C-c` anywhere in the table will update all formulas; the formulas will also be re-computed upon publication.

```
#+MACRO: uofc The University of Chicago
You can define a /macro/ like the line
above, and refer to it like this:
{{{uofc}}}.  Macros can also take
parameters, as in the date below.  There
are several predefined macros that can
expand thusly: {{{author}}}, {{{date(%Y)}}}.
```

You can define a *macro* like the line above, and refer to it like this: The University of Chicago. Macros can also take parameters, as in the date below. There are several predefined macros that can expand thusly: Keith Waclena, 2024.

```
#+LINK: gnu https://www.gnu.org
There's a special sort of macro for
URLs.  After defining the line above.
you can use it repeatedly in links like
these: go to the [[gnu][GNU website]] and
[[gnu:/software/emacs][Emacs website]].
```

There's a special sort of macro for URLs. After defining the line above. you can use it repeatedly in links like these: go to the GNU website and Emacs website.

```
Comments are not exported to your
published document.  You can comment out
a line easily.
# TODO say something interesting
Alternatively, you can use a block
comment to do many lines at once (and
block comments can be folded).
#+begin_comment
Say several
interesting
things
#+end_comment
You can also add a =COMMENT= keyword to a
headline, and none of the text under it
(including subheads) will be exported.
* COMMENT This Isn't Finished Yet
Write this section!
```

Comments are not exported to your published document. You can comment out a line easily.

Alternatively, you can use a block comment to do many lines at once (and block comments can be folded).

You can also add a `COMMENT` keyword to a headline, and none of the text under it (including subheads) will be exported.

See "Markup for Rich Contents" in the *Org* manual, "Hyperlinks" in the *Org* manual, and "Tables" in the *Org* manual for more information.

Simple Publishing (Exporting)

Now that you know how to use headlines to structure your text, and markup to format it, you can very easily publish your document in any of several formats.

You probably want to add some metadata, and perhaps tweak some publishing options (which Org calls export options); your first published document could be as simple as this:

```
#+TITLE: London Fog
#+AUTHOR: Joe Blow
#+EMAIL: joe@example.com
#+OPTIONS: toc:nil num:nil tags:nil
```

```
As Dickens said in [[https://www.gutenberg.org/ebooks/1023][/Bleak
House/]], "Fog everywhere. Fog up the river, where it flows among
green aits and meadows; fog down the river, where it rolls defiled
among the tiers of shipping and the waterside pollutions of a great
(and dirty) city."
```

See the Org manual for all the metadata possibilities. For most simple, memo-like documents, I usually use these options; changing any them from `nil` to `t` will toggle their meaning:

`toc:nil` don't generate a table of contents

`num:nil` don't number headlines

`tags:nil` don't include *tags*

There are couple dozen more of these.

You can export your published document via any of several backends; the defaults include:

LaTeX for a PDF or other printed formats

Beamer for a PDF that functions like a slide deck (e.g., to replace PowerPoint or Google Slides)

HTML for web publishing; you can upload the resulting `.html` file to your website or blog[310]

EPUB for an ebook suitable for your e-reader

ODT for an OpenDocument Text file (suitable for people using LibreOffice or MS Word)

Markdown for a Markdown file suitable for uploading to Github, perhaps

Texinfo for a document that's readable in Emacs via Info

Man Page for a Unix manual page

Plain Text for a neat-looking plain text file with filled paragraphs, etc

There are 45 other backends such as AsciiDoc and reStructuredText, and since one of them is `pandoc`, you can use that to export to even more formats.

For HTML exports, Org provides default CSS styling inline, but you can override it with your own, and there are many 3rd-party stylesheets you can choose from; I'm currently using Fabrice Niessen's ReadTheOrg for the HTML version of this book. For LaTeX exports, you can use any LaTeX class you like (there are thousands); I use the tufte-latex tuftebook class for the PDF version of this book.

See "Exporting" in the *Org* manual for more information.

[310] Just like I've done with this book.

The Fancy Bits

Let's take a peek at some of Org's other offerings.

Tagging

There are several mechanisms for organizing your information. First and foremost are *tags*, which are simply sets of keywords that can be assigned to any headline. This headline has two tags, `foo` and `bar`:

```
* A Level 1 Headline                    :foo:bar:
```

`C-c C-c` on a headline makes it easy to add or edit tags with Completion.

Tags are used to classify and categorize your headlines. They form an inheritance tree: that is, every headline is considered to have its explicit tags, and, implicitly, all the tags on all the higher-level headlines that contain it. For example, the headlines below that have been tagged with `lisp` are Lisp (explicit), Emacs Lisp, and Common Lisp (both implicit), and the headlines tagged with `oo` are Common Lisp, OCaml, and Java; `functional` applies to all of the headlines except Java:

```
* Lisp                :lisp:functional:
** Emacs Lisp
** Common Lisp                    :oo:
* ML                    :ml:functional:
** Standard ML
** OCaml                          :oo:
* Java                            :oo:
```

Tags are useful just as visual indications, but you can also use them to tie together many headlines across many files in the Agenda.

You can use Org's *sparse trees* to fold an entire Buffer so that only headlines with certain combinations of tags are visible, and you can then do an export that's limited to the visible parts of the Buffer.

See "Tags" in the *Org* manual for more information.

Hyperlinks, Attachments, and Drawers

In addition to storing information directly under a headline in the form of paragraphs of text or tables (perhaps recursively including a tree of sub-headlines), you can use Org's hyperlinks to link to other locations in your file or in other files (local or remote), on the web, in your email,[311] in your address book, and more. You can also *attach* other files to your headline; attached files are easily managed with Org's Attachment Dispatcher: it organizes them in subdirectories

[311] If you read your Email in Emacs...

related to your headlines, the most important features being that large data files and binary files are stored outside your document file; that you don't need to think about file- or directory names for the attached files; and that you can move headlines around without worrying about losing track of the associated files. Org's *drawers* are sort of like lightweight attachments that live directly in your file, but are kept hidden away (no matter how big they actually are) until you need to see them.

See "Hyperlinks" in the *Org* manual, "Attachments" in the *Org* manual, and "Drawers" in the *Org* manual for more information.

Refiling and Archiving

Org makes it easy to *refile* your valuable information in controlled ways within a file, or between files, without using error-prone cutting and pasting. `C-c C-w` (`org-refile`) will move (or copy) the current headline (or Region) to be under some other headline (the *target*), chosen with Completion. There's a powerful system for identifying targets, and they can be in other files as well.

A specialized version of Refiling is *archiving*. When you're in some sense "done" with a headline (which might represent a task), `C-c $` (`org-archive-subtree`) will refile it to the file's *archive file*. Exactly where and how archived headlines are stored is highly customizable, and you can choose extra information that gets stored with the archived item (the date of archiving, where it came from, etc). Archiving lets you keep your files lean and mean, but you can still find all your old information by searching your archive files.

See "Refile and Copy" in the *Org* manual and "Archiving" in the *Org* manual for more information.

The Agenda

The *Agenda* is Org's calendar, scheduler, project planner, TODO list, and search interface. It's job is to gather information of interest from a selection of all your Org files and display an overview of them in a special sort of dashboard Buffer that also makes it easy to jump to an item, or directly act on it right there in the view. You define the set of files that comprise the Agenda, via the Customize Facility—if you add a directory, all its files are included, and you can also add and remove files with a keystroke as you work.

See "Agenda Views" in the *Org* manual for more information.

Timestamps

You can use Org's Agenda to keep track of appointments, due dates, and the like. It's a much more powerful alternative to the standard Calendar.

A headline can have any of several types of *timestamps* associated with it. These are specially formatted strings that might look like this:

```
<2023-02-27 Mon 10:00-10:30>
```

and are easily inserted or modified with `C-c .` (`org-time-stamp`) and several other keystrokes that differentiate between scheduled times, deadlines, and other types. Existing timestamps support many convenient commands to tweak the date, jump to the Agenda for that date, and more.

Org also has powerful facilities for clocking and logging how much time you spend on work tasks, estimating how much time a project will take, and generating reports based on all this.

Here's an example Agenda dashboard generated from time-stamped entries across all my Agenda files and my Diary; I've also configured it to display holidays (it's actually quite colorful):

```
Week-agenda (W14):
Monday      3 April 2023 W14
  agenda:     Scheduled:  TODO BUGFIX
Tuesday     4 April 2023
  agenda:     13:20-14:30 APPT Doctor
  Diary:      15:30-16:30 D Meeting (Library JRL-220L)
Wednesday   5 April 2023
  Diary:      14:30-15:30 Sysadmin Meeting
  Diary:      17:00-19:00 Study Group
Thursday    6 April 2023
  Diary:      Joe Blow's Birthday: 36 years old
  Diary:      Passover
Friday      7 April 2023
  Diary:      Good Friday
Saturday    8 April 2023
Sunday      9 April 2023
  Diary:      Easter Sunday
```

The Agenda Buffer has 150+ handy commands for doing things like shifting the view from date to date and between daily, weekly, monthly, and annual views; directly killing, rescheduling, refiling, archiving, and adding new entries; changing priorities; filtering entries; tagging and untagging; narrowing the Agenda to certain files or Buffers; clocking in and out of tasks; searching and Occuring; and doing many of these actions to several marked entries at once. It would all be overwhelming, but I don't think anybody needs every one of these facilities; I only use a small subset and can barely guess what some of the others are for!

See "Timestamps" in the *Org* manual for more information.

TODO Lists

When you're taking notes, you can mark any headline as a TODO item with `C-c C-t` (`org-todo`). After `C-c C-t` a "New Project" headline will look like:

```
** TODO New Project
```

You could just type in "TODO", but `C-c C-t` is smart and each invocation will cycle through your *TODO keywords*. The default sequence of TODO keywords is simply `TODO` and `DONE`, but you can define your own sets on a file-by-file basis; perhaps `TODO`, `ACTIVE`, `DONE`, `DELEGATED`, and `CANCELED`. TODO states are distinguished between those that *need action* and those that *don't* or are in some sense finished; here perhaps `TODO` and `ACTIVE` need action and the remainder don't. `C-c C-t` cycles through these states in order.

When you transition an item into a finished state (like `DONE`, `DELEGATED`, or `CANCELED` here), Org can log a timestamp, prompt you for a note, and more.

The Agenda can display all your TODO items with a keystroke, filtered in a variety of ways; here's an Agenda TODO dashboard for one of my software projects:

```
Headlines with TAGS match: tint
Press 'C-u r' to search again
  refer:  TODO autocorrect for tint                                  :bug:tint:
  refer:  DONE implement -b and -e after Tint.eval is done           :bug:tint:
  refer:  DONE tint -b and -e should print result!                   :bug:tint:
  refer:  TODO option to terminate on tint error                :feature:tint:
  refer:  TODO if any tint errors, set exit status              :feature:tint:
  refer:  TODO Fred's request:                                  :feature:tint:
  refer:  TODO fs and vs should respect order of indices        :feature:tint:
```

See "TODO Items" in the *Org* manual for more information.

Spreadsheets

Org's table editor is great for producing beautiful tables in published output, but its tables are also useful for maintaining and manipulating data, like you might do with a spreadsheet program—especially since Org's tables have spreadsheet capabilities.

```
| Language   | Files |
|------------+-------|
| OCaml      |  2175 |
| Emacs Lisp |   156 |
| Tcl        | 13616 |
```

```
|------------+-------|
|            | 15947 |
#+TBLFM: @5$2=vsum(@I..@II)
```

A spreadsheet is just a table with special lines at the bottom that store all the formulas. Of course you don't have to enter or edit this line manually[312]; it's entered and maintained for you by Org. As you navigate from cell to cell in the table, a keystroke lets you enter a formula for the cell or for a whole column. Formulas support simple arithmetic, powerful functions from Calc, and even full-blown Elisp expressions.

Whenever you change any of the data or formulas in your table, you can recalculate the whole spreadsheet with `C-u C-c C-c` (or just one cell with a simple `C-c C-c`).[313]

When your spreadsheet gets complex, you can toggle on the *formula editor*, which makes it clear which formulas apply to which cells and allows easy editing of them. And when your spreadsheet is *really* complex and you're getting errors, you can turn on the *formula debugger* to see what's going on.

See "The Spreadsheet" in the *Org* manual for more information.

[312] Though you can if you want, thanks to plain text.

[313] You can also turn on automatic recalculation if you like.

Slideshow Presentations

I use Org to do all my presentations, instead of something like PowerPoint (I export to Beamer). See *Slideshow Presentations* for more information.

Literate Programming

Donald Knuth invented *literate programming* in 1984; he wanted to write computer programs in such a way that the code, along with what would normally be explanatory comments, could be read as literature. He implemented his TEX typesetting system this way, resulting in a beautiful 483 page book describing this large and complex program. The idea is that the source code of a literate program can be processed in two ways: it can be *tangled* to generate the source code of the program, which can be compiled or evaluated, or it can be *woven* to generate code for typesetting software to produce a book, article, or web page.

One of the tricky things about this is that a given programming language may require that parts of the program appear in a certain order, to make the compiler happy, which might not be the best order for the reader of the woven book to understand how the program works.[314] A literate programming system needs to allow the program to be written "out of order"!

[314] Many languages require functions to be defined before they're used, so a purely top-down presentation means reading the program backwards.

Org supports literate programming in a straightforward manner: just write your text in Org's markup language, and express your program source code in separate `#+begin_source` blocks. If you need to change the order of things, use Org's Noweb syntax.

Now you can tangle your literate program into compilable source code with `M-x org-babel-tangle-file`, and weave (typeset) your document just by exporting it via your preferred backend.

This book is in a small way a literate program, in that I tangle all the recommended Init File snippets scattered throughout the book into an actual executable Init File available for download. Many Emacs users maintain their own Init Files as proper literate programs, as I do with my own.

See "Noweb Reference Syntax" in the *Org* manual for more information.

Evaluating Code

One of the most amazing features of Org is that it can be used to write *dynamic* documents that are a mix of static text and the results of evaluating code. In other words, parts of your document can be *computed* every time you export it for publication.

In addition to exporting nicely formatted and colorized code for your published documents, source blocks can be evaluated in your Buffer to generate document content. For example, instead of typing in a table containing some lines of data, or even inserting it from some data file, you can use a source block that can read in the data and process it into an Org table (or any other sort of presentation: a numbered list, an example block, etc).

Your source block needn't merely read in existing data and reformat it: it can calculate or generate the data from scratch. You might use a stats package like R to do a statistical analysis of some data and generate plots to be displayed in your document.

Any source block can have an `:exports` header that says whether to publish only the source code itself (the default), or to only export the *result* of evaluating the code (or both).

Normally, the code and/or results appear in the published document at the location of the source block, but if you give a source block a name, you can define the code in one location, and then *call* it by name elsewhere, possibly in multiple places. Source blocks can also take parameters, which can have default values. Org calls such named blocks *Babel* functions. This function computes the number of years from some date to now:

```
#+name: years-since
#+begin_src emacs-lisp :exports none :var when=1985
  (number-to-string (- (string-to-number (format-time-string "%Y" (current-time))) when))
#+end_src
```

I can call this function elsewhere like so:

```
#+call: years-since(when=1918)
```

which produces a one-line result:

```
106
```

Note that I provided a default value, 1985 (GNU Emacs's birth date), for the `when` parameter, since I more than once in this book mention how long GNU Emacs has been around; if I call the function without giving the `when` parameter, it will compute the age of Emacs.

A function that produces a small scalar value is often more usefully called *inline* like so:

```
GNU Emacs has been flourishing for call_years-since() years.
```

which results in: GNU Emacs has been flourishing for 39 years.

There is also a `:results` header that let's you specify how to interpret the results of evaluating the block: results can be Org tables, lists, saved in files, and more. `#+call:` and inline calls can specify `:exports` and `:results` headers that apply only to that call.

You can also evaluate any source block with a `C-c C-c` to see how your calculation is working: the results (if not suppressed by a header) will appear in your Buffer.

Security Issues The fact that Org Mode allows you to evaluate code from a file raises security concerns. Of course, a dynamic Org document that you evaluate in Emacs is no more dangerous than a file of Python code that you evaluate in the Python interpreter, but people who don't know about Org might not expect the possibility of evaluation.

Fortunately, Org (and Emacs in general) is very careful about this. By default, Org will ask you for confirmation before evaluating each source block. If you're surprised by this because you loaded and tried to export a file written by someone else, just say "no" or hit `C-g` (`keyboard-quit`) and then investigate the situation.

Such confirmations are unworkable if you're editing a document that uses a lot of executable blocks[315], so we usually set `org-confirm-babel-evaluate` to `nil` in a file-local variable. Since Emacs asks you to confirm the setting of this variable when you visit any file that sets it, you won't be able to evaluate any code unexpectedly. See *Security Concerns* for more information.

[315] I make 1,577 Org source block function calls in this book; I don't want to say "yes" that many times every time I export it.

See "Working with Source Code" in the *Org* manual for more information.

Metaprogramming

By *metaprogramming* I mean a computer program that is written in several programming languages simultaneously. You might think of a Unix shell script that allows you to connect, via pipes, several complete programs, written in various languages, as a kind of metaprogram.

Org is more meta than that, because it doesn't require that all the different programs be compiled and installed as separate standalone executables.[316] Instead, you just embed all the code in all the languages as Org source code blocks in your single metaprogram document.

[316] Or installed as interpretive script files.

Any given source code block can contain code in any supported programming language: Emacs Lisp, Python, Awk, Clojure, Haskell, OCaml, Shell: what have you.[317] Out of the box, Org supports 48 languages, the Org Contrib project adds 20-odd more, and there are 75 more in the Package Manager.

[317] And even Org Mode itself, for some recursive twistiness.

If you name a source block, then another source block can call it like a function and use its result—even if the two blocks are in different languages! The input to a source block can also be a manually created Org table, including a spreadsheet.

Here's a list of the languages Org knows out-of-the-box (computed by an Org source block, of course):

awk	C	calc	clojure	comint	core
css	ditaa	dot	emacs-lisp	eshell	eval
exp	forth	fortran	gnuplot	groovy	haskell
java	js	julia	latex	lilypond	lisp
lob	lua	makefile	matlab	maxima	ocaml
octave	org	perl	plantuml	processing	python
R	ref	ruby	sass	scheme	screen
sed	shell	sql	sqlite	table	tangle

Reproducible Research

Many of the counts, diagrams, graphics, tables, and images in this book were produced via Org metaprogramming, but a much more interesting use case, and the reason this feature was added to Org in the first place, is the facilitation of *reproducible research*. The idea here is that instead of the usual scientific research paper describing some data, a methodology, and summarizing the results, the paper should actually *include* the actual data, *and* the source code used to analyze

and summarize it, so that other researchers can readily reproduce it.

An Org paper can include the data via attachments or drawers, and all the source code as in-line source blocks which can be evaluated right in your Emacs Buffer. See Schulte *et al*. This is essentially a plain-text version of Jupyter Notebooks.

Org Outside of Emacs

Org's markup language is supported by Github as an alternative to Markdown for `README` files[318], is supported as an input language by `pandoc`, and is understood as a syntax by other editors like `vim` and `VS Code`, though it should be noted that the more powerful Org features (like the spreadsheet and metaprogramming) are typically not supported.

[318] GitHub only supports the most basic Org markup features, however.

In the use of Org for Ubiquitous Capture and note-taking, it would be very handy to be able to create and edit your Org notes on your tablet or phone—and you can.

As of 29 December 2024, there are four main Org-compatible apps. For iOS there's beorg, orgro and MobileOrg, and for Android, orgro and Orgzly. There are also two web apps which will work on any device with a web browser: organice and org-web. All these apps typically work with a centralized cloud file store, such as DropBox, Google Drive, or iCloud.

The only one of these that I've tried is Orgzly; I use it daily and am extremely happy with it. I'm averse to using cloud file stores, so I have Orgzly synchronize directly with my laptops and desktops via Syncthing, and easily resolve occasional edit conflicts with Ediff.

The original version of Orgzly is apparently now abandonware, but thanks to free software, the community has responded with a new fork that's maintained and adding new features. This new version is *Orgzly Revived*, and it's currently available from Google Play and F-Droid. I haven't yet switched to it but I probably will with my next new phone.

References

- Ballantyne, Tony. 2018. *My Emacs Writing Setup.* `https://github.com/ballantony/emacs-writing/blob/main/EmacsWritingTips.org`.

- Free Software Foundation. 2020. *The Org Manual.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/org.html`. Read in Emacs with `M-x info-display-manual RET org RET`.

- Knuth, Donald E. 1984. "Literate Programming." *The Computer Journal* 27, no. 2: 97–111. `http://www.literateprogramming.com/knuthweb.pdf`.

- Schulte, Eric, Thomas Dye, Dan Davison and Carsten Dominik. 2012. "A Multi-Language Computing Environment for Literate Programming and Reproducible Research." *Journal of Statistical Software* 46, no. 3: 1–24. doi:10.18637/jss.v046.i03.

- The Org Mode web site.

- Worg, the Org Mode community.

There's an Org Mode Reference Card; for languages other than English see the web site.

Printing

Emacs has many convenient and useful printing commands you can use. You can print a file or any Buffer[319], with or without automatic pagination and headers, and with or without colors and fonts that match what you see in the Buffer. And of course for serious publication-style printing, you can *typeset* various markup languages like LaTeX and Org for eventual printing.

[319] Whether or not it's visiting a file.

The very first thing to do is to see if printing "just works" for you! First, make sure you can successfully print from *outside* of Emacs, in whatever normal way you do so. If that works[320], try printing from Emacs: just switch to any Buffer and say `M-x print-buffer`. If that works, congratulations! If it doesn't, skip to *Configuring Printing for Unix* and good luck!

[320] If it doesn't, you need a different book...

Plain Printing

Emacs printing is mostly organized around printing a Buffer. (To print a file directly, just Visit it first. You can also print a file directly from Dired with Dired's `P` (`dired-do-print`) command.)

Basic monochrome printing that should work with even the oldest[321] printers consists of the four commands in Table **??**.

[321] I.e. non-PostScript printers, even ancient dot matrix printers or line printers. Though I've also encountered PostScript printers that are too snooty to print plain text and insist that it be converted to PostScript first.

	Paginated	Not Paginated
Buffer	`M-x print-buffer`	`M-x lpr-buffer`
Region	`M-x print-region`	`M-x lpr-region`

Table 48: Plain Printing Commands

You can print the whole Buffer, or just the Region, and you can print with pagination or without. Pagination adds a header that identifies the Buffer, and adds reasonable margins and page numbers. This is actually done by the old Unix program, `pr(1)`. You can Customize `lpr-page-header-program` to change that.

These four commands are for basic printing of plain text, like listings of programming language source files and the like.

Postscript Printing

Most modern printers, including home printers, are PostScript printers[322]; PostScript is actually a programming language for describing page layout that printers understand. Emacs has a collection of commands that convert your Buffer to PostScript and then send it to a printer; see Table 49. The main advantage of these commands is that they can also print in color and in various fonts. All these commands paginate and add page headers.

[322] In my workplace, our printers are actually networked photocopiers that speak PostScript.

	Print	... with Faces
Buffer	`M-x ps-print-buffer`	`M-x ps-print-buffer-with-faces`
Region	`M-x ps-print-region`	`M-x ps-print-region-with-faces`

Table 49: PostScript Printing Commands

Each of these commands interprets a Prefix Arg to "print" to a prompted-for file, instead of to a printer.

You almost certainly want to use these commands instead of the plain printing commands above, and I would guess you'd almost always want color. To simplify things, you could define an *alias* for this in your Init File like so:[323]

[323] FYI, you don't want to name your alias `print`, which is the name of an important low-level Lisp function...

```
(defalias 'my-print 'ps-print-buffer-with-faces)
```

after which you can print your Buffer with `M-x my-print`.

There's an analogous set of commands that *spool* instead of print; see Table 50. This is an old computer jargon term that means to queue things up for printing, and then print them later.

	Spool	... with Faces
Buffer	`M-x ps-spool-buffer`	`M-x ps-spool-buffer-with-faces`
Region	`M-x ps-spool-region`	`M-x ps-spool-region-with-faces`

Table 50: PostScript Spooling Commands

After using one or more of these commands, you can send the whole bunch of spooled documents to your printer with `M-x ps-despool`.

There are lots of ways to Customize PostScript printing; try `M-x customize-group ps-print`, and see "PostScript Variables" in the *Emacs* manual.

"Printing" to HTML

You can also convert any Buffer to colorized HTML, suitable for installing on a web site or attaching to an Email; see Table 51.

`M-x htmlize-region-save-screenshot` is designed for pasting colorized HTML into an Email or the like; it uses inlined CSS so the colorization is stand-alone.

`M-x htmlize-buffer`	Convert Buffer to HTML
`M-x htmlize-region`	Convert Region to HTML
`M-x htmlize-region-save-screenshot`	... saving to Kill Ring
`M-x htmlize-file`	Convert a file to HTML and save it
`M-x htmlize-many-files`	... do the same for many files at once
`M-x htmlize-many-files-dired`	... via marked files in Dired

Table 51: Htmlize Commands

Configuring Printing for Unix

Hard-copy printing is a complex topic, at least on Unix systems, and the Emacs interface to printer configuration reflects this. As a long-time Unix user, I've never had to set up printing under MS Windows or Mac OS—I'll assume that it just works out of the box on those OS's.[324] But on Unix, there are scads of ways printing might be set up, and I can't address all that here. I'll just mention that in my experience, many current Unix systems use CUPS for printing, and CUPS provides both the traditional Berkeley Unix and System V command-line print spooling commands in addition to its web interface.

[324] That's why you use them instead of Unix, right?

Emacs uses the `lpr(1)` command (the Berkeley flavor) as the default program to print your Buffer. Some systems use `lp(1)` (the System V flavor) instead; you can `M-x customize-variable lpr-command` to change it.[325]

[325] Your system may use an entirely different command; if you can print from the command line, you can configure Emacs to use it.

Emacs may need to know the name of your printer, if it hasn't been set up as the system default. Customize `printer-name` to fix that. For some reason, on my work computer, which uses CUPS to talk to a campus-wide remote printing service, I have to set `printer-name` to the empty string:

```
(setq printer-name "")
```

Why, I don't know! This is the fault of CUPS (or our printers), not Emacs; I mention it as an example of the kind of fiddling you might have to do.

You may need to add some *switches*[326] to the `lpr-command`; Customize `lpr-switches` for that. I need to add my campus username to be authorized, for example:

[326] AKA "command-line optons"...

```
(setq lpr-switches '("-U" "myusername"))
```

You may need to change more things: finally, I need to set:

```
(setq lpr-add-switches nil)
```

in order to prevent Emacs from adding some standard switches each time it prints, which aren't accepted by our system.

If none of that helps you, you should read the manual; see "Printing" in the *Emacs* manual, and then see what you can do via `M-x customize-group` for `lpr`.

UNFINISHED *Modal Editing*

Third-Party Packages

The Emacs package repositories I recommend currently have 6,216 third-party packages available for installation. These packages are written by enthusiastic and generous Emacs users and contain a lot of very useful code. See *The Package Manager* for how to find, install, and manage them, and *Security* for safety information.

What kind of packages are available? There are scads of Major Modes for every imaginable programming language; Minor Modes to add convenient editing features or fix a problem that annoyed somebody or just scratched an itch; packages that implement new Emacs applications; Emacs interfaces to external applications, and to web services I've never heard of; games and amusements; plenty of Emacs themes; and who knows what else! (Recently 18 AI-related packages have appeared.) Here I'll just mention a tiny selection of additional third-party packages you might want to investigate, some because they're popular and others because they're unusual. I use some of these but definitely not all—in particular, I haven't even tried many of these, so don't take these as recommendations. Just use `C-h P` (`describe-package`) with any of the package names below for more information.

`csv-mode` Major Mode for CSV files

`darkroom` remove visual distractions and focus on writing; see also `olivetti` and `writeroom-mode`

`dired-duplicates` find duplicate files locally and remotely

`emacs-everywhere` use all the power of Emacs to edit non-Emacs text entry boxes (e.g. in Gmail or any other web page) in a pop-up Emacs Window

`hyperbole` kitchen-sink package whose main job is to turn practically everything into a hyperlink; also includes yet-another-outliner and -contacts manager, and a window manager (for your Emacs Frames and Windows)

`magit` powerful interface to the Git version control system

multiple-cursors make the same edits at multiple places in your Buffer at the same time; sort of a sometimes-alternative to Keyboard Macros

operate-on-number apply arithmetic functions to a number at Point

org-drill study flash-card style via the powerful Spaced Repetition method; Emacs version of Anki

vlf Minor Mode that allows instant viewing, editing, searching and comparing of *very* large files—terabytes in size

which-key Minor Mode that reminds you of all the possible continuations of a Prefix key like `C-x 4` or `C-c`; great for newbies

I've already recommended and included in the book's Init File the Incremental Narrowing Frameworks `vertico` and its add-on `marginalia`; `windmove` for switching Windows; and `wgrep` for *Writable Grep*.

Here are some of the other third-party packages that I've mentioned, and sometimes covered in detail, elsewhere in the book:

Icicles and `selectrum` Completion; see *Third-Party INFs*

pdf-tools PDF viewing; see *Better PDF Handling with PDF Tools*

nov reading EPUB e-books; see *Document Files (PDFs and the Like)*

disk-usage find out where all your disk space has gone; see *Third-Party Directory Tools*

yafolding fold many kinds of text; see *Yafolding Mode*

mew, *wanderlust*, *and notmuch* mail user agents; see *Reading Mail*

elfeed RSS feed reader; see *Web and News Feeds (Syndication)*

mw-thesaurus thesaurus; see *Dictionaries and Thesauri*

fish-completion and bash-completion much improved Completion for `shell-mode`; see *Recommended Third-Party Packages*

goto-last-change and goto-chg navigate to the location of the last change you made in your Buffer; see *Move Via Your History of Changes*

Security Concerns

Computer security is a vexing topic, and I am not a security expert. Please remember that it's your responsibility to determine the safety of every program you choose to use, including Emacs and any third-party packages. Any program you run can do anything that your operating system lets it do. But because the nature of Emacs is different from most programs, I will mention a few security issues for you to be aware of.

Since Emacs contains a programming language interpreter (it's a Lisp Machine, remember), from a security point of view it's more like Python, say, than it is like MS Word. When you use Python, of course you understand that the Python interpreter is going to evaluate code: that's the whole point. The same is true of Emacs and Emacs Lisp.

But because many people think of Emacs as "just a text editor", they may be surprised Emacs can evaluate code, and surprised at when exactly that can occur. After TECO, Emacs was probably the first programmable editor. But many editors since have modeled themselves on Emacs and can evaluate code in the form of *macros* of some sort, which historically led to *macro viruses*. And spreadsheets (like Excel) of course contain executable *formulas*. And web browsers execute Javascript code whenever you open a web page[327].

[327] And used to execute other kinds of code, like Java applets and Flash.

So let's take a look at some of these cases in Emacs to make sure we understand them.

File- and Directory-Local Variables

We've already mentioned that you can add code to a file that will set the value of a Buffer-Local Variable when you Visit the file. This is an extremely convenient shortcut for the process of: 1. visiting a file, 2. remembering that you now want to change the values of some Buffer-Local Variables, and 3. changing them with `M-x set-variable`.

The same facility allows you to put arbitrary code in a file to be evaluated upon Visiting. Obviously this could be dangerous if you Visit a file that was modified by a malicious person—perhaps a file that was emailed to you or that you downloaded from the web.

Suppose we have the file `foo.txt` that contains exactly this text:

```
Hello.

Local Variables:
eval: (message "Hello there.")
End:
```

The `Local Variables:` block at the end of the file sets the pseudo-variable `eval` to the Elisp function call `(message "Hello there.")`. When you Visit the file, Emacs pops up a Window like this:

```
The local variables list in foo.txt
contains values that may not be safe (*).

Do you want to apply it?  You can type
y  -- to apply the local variables list.
n  -- to ignore the local variables list.
!  -- to apply the local variables list, and permanently mark these
      values (*) as safe (in the future, they will be set automatically.)
i  -- to ignore the local variables list, and permanently mark these
      values (*) as ignored

  * eval : (message "Hello there.")
```

As you can see, Emacs clearly displays the code that could be executed, and asks you whether or not you want to do so. If this ever surprises you (because *you* didn't write this code, or you're not sure exactly what it does), just say `n` and Emacs will finish Visiting the file *without* evaluating the code. Typing `i` will cause it to *never* evaluate this variable, even in future, different, files.

If in fact you are okay with evaluating the code, and type `y`, you'll see (in this example) the message "Hello there." displayed in the Echo Area, since that's what `message` does.

Because EIPNIF, you can also tell Emacs that it's always okay to evaluate code, any code, from any file, without asking any questions. I *strongly* discourage you from doing this, of course (and I don't do so myself).

Variable Safety

Less extreme than the special `eval` pseudo-variable are ordinary Variables that you might set in a file. That might look like this:

```
Local Variables:
crazy-variable: "strange value"
other: 12
End:
```

Here we're setting one Variable to a string and one to an integer. Emacs will go through exactly the same dialog with you as for `eval`, above. While `eval` is considered to never be safe, these two Variables, which I made up, are also considered to be unsafe because Emacs knows nothing about them.

But because many such settings are perfectly innocent, Emacs has a way to avoid asking you about all of them. When a Variable is defined, the programmer can specify its *safety*. This is done by assigning a *predicate*[328] that tests whether or not a given value for that Variable is safe. For example, the documentation for the variable `python-indent-offset`, which specifies the number of leading spaces used to indent a line of Python source code in `python-mode`, says:

> This variable is safe as a file local variable if its value satisfies the predicate 'integerp'.

`integerp`, as Emacs will tell you if you ask (with `C-h f` (`describe-function`)), returns true if and only if the value is a simple integer. So this File-Local Variable setting:

```
python-indent-offset: 4
```

is considered safe, and Emacs won't ask you to confirm it, whereas these two:

```
python-indent-offset: "foo"
python-indent-offset: (steal-identity!)
```

are *not*.

When all the File-Local Variables in a file pass their safety tests, you can Visit the file without the confirmation dialog. If any of them fails, Emacs will use the dialog to check with you.

[328] That is, a function that returns true or false.

Third-Party Packages

When installing third-party packages via the Package Manager, remember that a third-party Emacs package can do anything your operating system would allow you to do with Emacs or Elisp yourself, including deleting files or stealing your personal data! In this sense, Emacs is no different than every other package manager—whether for a programming language, the app store on your phone, or an application like a web browser.

In an ideal world, you would personally vet the source code for any package before you install it[329], but this assumes you're a competent Elisp programmer, and realistically, very few people are willing to go to all this trouble and are more trusting or risk-taking than that. But it is at least possible: unlike the vast majority of phone apps, you have complete access to the source code of Emacs packages, thanks to free software. Even if you don't vet the code, it's the nature of free software that there's the potential for many people besides the original author to vet it, and "many eyes make code safer".

[329] As you ideally would for every phone app you install...

The GNU and NonGNU ELPA repos are managed by the Emacs developers and hosted by the GNU project, and are probably more secure than other repos. That being said, I currently use some 154 third-party Elisp packages from GNU and NonGNU ELPA and from MELPA, the Emacs Wiki, and Github, have used many more in the past, and have never in 39 years encountered any malware. But that could change tomorrow, and it's up to you to do what you consider to be due diligence. Do some research before installing: search the package on the web and see what people say about it; visit the package's home page (very likely to be found on Github; `C-h P` (`describe-package`) will tell you), and see how many people are using it.

Package Signatures

Packages can have *cryptographic signatures*, and Emacs can validate them before installation. Not all packages are signed, however, and the default is to allow unsigned packages to be installed. You can Customize `package-check-signature` to make this more strict if you like. Please note that a valid signature in no way implies that a package contains safe code; it just verifies that the package hasn't been modified since its author signed it. It's up to you to determine whether or not you trust the author. See "Package Installation" in the *Emacs* manual for more information.

Compiling Elisp Code

When you install a package, Emacs *compiles* the code for efficiency, but the act of compilation can also involve evaluating some of the code. So if you're really worried about some code, vet it before you even install it.

Evaluating Code in Org Mode

Just as many programming language Major Modes provide a facility to evaluate source code, Org Mode also let's you define source code

blocks and will evaluate them when you export the file. The Org spreadsheet will also evaluate arbitrary Elisp functions. See the Org Mode chapter for more information, and especially the *Org* manual.

Authentication

Emacs sometimes acts as an intermediary when you are *authenticating* yourself. Examples include editing a file via Tramp's `sudo` method, connecting to your email provider via your Emacs mailer, or logging in to a remote host via Tramp. In these cases, you will be prompted for a password in the Minibuffer. As you make more and more use of Emacs, this might eventually happen often enough to be annoying: then it's time to set up Emacs authentication.

Emacs authentication has three built-in modes:

- The simplest, and the default, form of authentication is to simply store your passwords in a file so Emacs can just look them up and submit them for you.

- Emacs also supports the freedesktop.org Secrets API, used by the Gnome, KDE, and Xfce Unix desktops; if you're already using one of their password managers you probably want to have Emacs use it too.

- Finally, Emacs can use `pass(1)`, "the standard Unix password manager".

I use `pass(1)` for my web site passwords, but I use an authentication file for my Emacs password needs. You can use any of these, or combine several. I'll only describe file-based authentication here; see the auth-source manual for more information.

File-Based Authentication

Check the value of the User Option `auth-sources` with `M-x customize-variable`; this is a list of filenames and the first filename is the default; on Unix systems this will be `~/.authinfo` and I'll assume it. I think that you should encrypt this file, but it's neither mandatory nor the default. The encrypted version is `~/.authinfo.gpg` (which will be listed as the second filename in `auth-sources`).

To make sure you're using an encrypted file, Customize `auth-sources` via `M-x customize-variable` and make the `.gpg` filename the only member;[330] you can change where it lives if you like.

[330] Or, move it so it is the first member of the list.

Emacs may have created the default (unencrypted) file for you if it has ever asked if you want to save a password (and you answered yes). So if you're already using an unencrypted authentication file (check for its existence), I suggest you encrypt it (see *Symmetrically-Encrypting an Existing File*).

Note that for historical reasons, the `.authinfo` file is also referred to as the "netrc" file in some documentation. Old-timers will feel me.

`.authinfo` File Format

The `.authinfo` file consists of one line per password, and the basic format of the line is:

```
machine MYMACHINE login MYLOGINNAME password MYPASSWORD port MYPORT
```

In general, it's a sequence of field-name / field-value pairs, and the order of the pairs doesn't matter. The field names above suffice for many kinds of services—remote logins, email authentication—but some services will use different or additional field names. The `port` field was originally a TCP/IP port number, but you can also use the symbolic port name from `/etc/services`, and it's also used loosely to identify services that don't actually use a port (like `port sudo` to specify your `sudo(1)` password).

The fields are space-separated, so if you have a space in a password (or in any of the field values) you can put the whole value in double- or single-quotes. If you have a quote in a field value, quote the whole value with the other style of quotes, and if you have both types of quote in a field, then, to quote the Knight Templar, "you chose poorly".[331]

[331] By which I mean, the file format can't cope with that.

When Emacs needs a password, the lines in your file are considered in order, and the first to match the situation is chosen. If you have these lines:

```
machine example.com login joeblow83 password geheimnis port smtp
machine example.com login joeblow83 password hemmelig
```

then the first will be used when doing SMTP (email-sending) authentication at `example.com` but the second line will be used for all other services at that host.

Unless you name your authentication file strangely, when editing it, Emacs will use `authinfo-mode`, which does simple colorization, but also obfuscates the value of the password field, making it look like four asterisks. This is to defeat shoulder-surfing; just move Point inside the asterisks to see the password.

Third-Party Add-Ons

The Package Manager has add-ons for more authentication backends:

`auth-source-1password` 1password integration

`auth-source-gopass` Gopass integration

`auth-source-keytar` keytar integration

`auth-source-kwallet` KWallet integration

`auth-source-xoauth2` XOAUTH2 integration

References

Free Software Foundation. 2022. *Emacs auth-source.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/auth.html`. Read in Emacs with `M-x info-display-manual RET auth RET`.

Programming the Lisp Machine

> What one fool can do, another can. — Silvanus P. Thompson, *Calculus Made Easy*, 1911

> You can avoid learning elisp and still be very productive using emacs, but chances are if you're like most people you will get sucked in eventually as the lure of sanding the rough edges off of some mode or other becomes too great :) — Chris Patti

Unlike most lesser but still somewhat-customizable applications, Emacs provides a clear path from your first customization tweak to power user to full-blown extension programmer, primarily because Emacs is itself written in the language used to customize it.

Customization in Emacs Lisp

In the old days, the only way to customize Emacs was by adding Elisp to your Init File, but for at least 27 years—since version 20—the Customize Facility has provided an interactive forms-based system for most of your customization needs. I'm embarrassed to say that I used to disdain Customize (I guess I thought it was too hand-holdy, and anyway, writing Elisp is fun!)—but I was a fool. Customize is very powerful and has major advantages, and I encourage you to use it as much as possible; see *The Customize Facility*.

That being said, there *are* a few sorts of customizations that you can't do, or can't do conveniently, via Customize. First and foremost is setting up custom key bindings; another is complex customizations that require conditional logic (say, dependent on which host your Emacs is running on, or the version of your Emacs). Also, if you're adding a non-trivial lambda expression to a hook, it's typically much nicer to edit it in your Init File in `emacs-lisp-mode` than to edit it in a hole in a Customize form. Additionally, some authors of 3rd-party libraries, especially older ones, may have been too lazy to set up Customization for their User Options.[332] Finally, if you start writing your own Elisp functions or defining your own Faces, your Init File is the place to put them!

[332] I'm afraid I fell into this category until recently…

Where is My Init File?

For historical and political[333] reasons, there are several acceptable locations for your Init File. The oldest, most traditional, filename is `~/.emacs`, though Emacs now prefers `~/.emacs.el` (adding the standard file extension for Elisp files). These locations use the root of your home directory, but there are good reasons to prefer putting it in your User Emacs Directory, which by default is `~/.emacs.d/` under the name `init.el`, or, in full, `~/.emacs.d/init.el`. I recommend the latter: Emacs will eventually create this directory anyway, to store other files like packages you've installed, Abbreviations, or your saved desktop, so why not keep your Init File in the same place? For more information, see "Find Init" in the *Emacs* manual.[334]

[333] POSIX...

[334] Microsoft users can see the Wiki for how this translates to Windows.

Basics of Elisp Syntax

While you don't really need to be an Elisp programmer to do simple Init File customizations, you do need to understand the bare minimum of Lisp syntax to do it correctly. Fortunately, few serious programming languages have a simpler syntax than Lisp![335]

A Lisp expression is either an *atom*, or a list of expressions—note the recursive definition.[336] The simplest atom is a *symbol*, which you can think of as a word, and a *list* is a space-separated sequence of expressions surrounded by parentheses. So all of these are expressions:

[335] Considering only "real" programming languages, I might say only Forth is simpler...

[336] This is a bit of a simplification...

`nil` an atom (symbol)

`use-file-dialog` another atom

`(nil use-file-dialog)` a list of two atoms

`(nil (nil use-file-dialog))` a list of two expressions, an atom and a (sub-)list

That's almost all there is to it! Your Init File consists of a sequence of such expressions, separated by (optional) blank lines and *comments*. Practically speaking, all your top-level expressions will be lists. Comments are notes to the reader and are ignored by Elisp; a comment starts with a semicolon and extends to the end of the line. Here's a possible snippet from an Init File: a comment, followed by an expression that's a list of three symbols:

```
;;; turn off GUI dialogs...
(setq use-file-dialog nil)
```

Note that using three semicolons to start the comment is just a convention[337]; just one would be sufficient.

[337] Applying when a comment takes up a whole line.

There is of course a little more—but surprisingly little—to Lisp syntax than this. In particular, there are a few types of atoms other

than symbols, which have their own syntax: things like numbers, strings, and such; see *Variables and Symbols* for details.

Quoting

One final bit of syntax is the *quotation*: any Lisp expression can be prefixed with a single quote (apostrophe) character `'` in order to prevent its *evaluation*. Here are two quoted expressions: `'display-line-numbers-mode` and `'(partial-completion substring flex)`. Note that we use just one `'` as a prefix, not a pair of them!

I can't reveal the truth of when you need to quote something and when you don't in the space I have available: this is at the heart of understanding the semantics of Lisp. See the *Eintr* manual for a complete discussion. But I will give a few hints below.

Setting User Options

Let's see how to set a simple User Option in your Init File (even though you should prefer `M-x customize-option`). I personally hate the GUI dialog boxes that Emacs will occasionally pop up; I want Emacs to always use the Minibuffer instead. There are two User Options to control this: `use-file-dialog` and `use-dialog-box`.

The first step in setting a User Option is to *read the help* so that you understand what values are legitimate, so do `C-h v` (`describe-variable`) on each of them. Turns out both of these are simple Booleans: I want to set them to `nil` (i.e. "false", or "off").[338]

[338] If you want to set them to *on*, you'd use the value `t`, which is the conventional value for "true" or "on"—but actually, in Elisp, any non-`nil` value counts as true.

The basic Elisp function for setting a variable's value is `setq`. It takes two parameters: the variable name, and the new value. So this snippet does the job:

```
;;; turn off GUI dialogs...
(setq use-file-dialog nil)
(setq use-dialog-box nil)
```

Some variables want to be set to a number or a string; just write the obvious:

```
(setq some-variable "this is a string")
(setq some-other-variable 12)
```

But some variables want to be set to a *symbol*. For example, `locale-coding-system` says what to interpret as your *system locale*. Your OS usually tells Emacs what this is, but if it doesn't, you could set it in your Init File. The point is that this variable should be set to a symbol—perhaps `utf-8-unix`. You would think this would do the job:

```
(setq locale-coding-system utf-8-unix)            ; WRONG
```

But this will generate an error. Since symbols serve as Lisp variables. Elisp will try to evaluate `utf-8-unix` as a variable to get its value—but it's not a variable with a value: it's just a symbol standing for itself. So you have to quote it to prevent it from being evaluated, like so:

```
(setq locale-coding-system 'utf-8-unix)
```

Remember, when the help for a variable says its value should be a symbol, you need to quote the symbol.

When a variable says its value should be a *function*, you also want to quote it. This is for the same reason, because most functions are represented as symbols. The help for `confirm-kill-emacs` says:

> How to ask for confirmation when leaving Emacs. If nil, the default, don't ask at all. If the value is non-nil, it should be a predicate function; for example 'yes-or-no-p'.

I have this in my Init File:

```
(setq confirm-kill-emacs 'yes-or-no-p)
```

The same goes for when a variable wants a list: you'll need to be sure to *quote* the list. This is because lists of data look like function calls: or if you prefer, function calls are expressed as lists. This keeps the syntax very simple, at the cost of needing to know what's data and what isn't.

`world-clock-list` configures the cities for `M-x world-clock` (see *World Clock*). I set it to four cities:

```
(setq world-clock-list
      '(("America/Chicago" "Chicago")
        ("America/New_York" "Kalamazoo")
        ("America/New_York" "Syracuse")
        ("Europe/Vienna" "Vienna")))
```

The value here is a list of four lists; each sub-list is a list of two strings. Note how I quote the outer list (but I don't need to quote any of the contained values: the outer quote covers the whole thing). If I don't quote the list, I get an error:

```
Invalid function: ("America/Chicago" "Chicago")
```

So when setting a variable to a list, quote the list.

Setting Default Values

Some variables are declared *Buffer Local*; when you ask for help about them, the documentation will say: "Automatically becomes buffer-local when set". Buffer Local variables are meant to potentially have

a different value in every Buffer. So customizing one actually means setting a *default* value, which will be the variable's value in any Buffer where you haven't given it a presumably different *local* value.

`setq` will only set the local value of a Buffer Local variable; to set the default value, we need to use a different function: `setq-default`.

I recommend setting the variable `indent-tabs-mode` to `nil` so that Emacs uses only spaces—never tab characters—for indentation (see *Tabs vs Spaces*). Here's how to do it:

```
;;; never use tabs to indent
(setq-default indent-tabs-mode nil)
```

So remember, when you read the Help and it says the variable is Buffer Local, use `setq-default`.

Setting Hooks

A *Hook* is just a regular variable with a particular purpose: to hold a list of functions; see *Hooks* for an explanation. While you could technically set a Hook in your Init File with `setq`, there's a special function to make it easier: `add-hook`. `add-hook` is preferred to `setq` for this purpose because it does some extra work that's appropriate to Hook variables.

Suppose you want to turn on spell check in `text-mode` and other Major Modes derived from it. This is the right way to do it:

```
(add-hook 'text-mode-hook 'flyspell-mode)
```

`flyspell-mode` is of course a function that toggles a Minor Mode on and off, and such Minor Mode functions are the most common things to add to Hooks.

If you look at `text-mode-hook` with `C-h v` after starting Emacs with the above line in your Init File, you'll see that its value is a list, containing at least the symbol `flyspell-mode`.

Since `flyspell-mode` is a function, you know you have to quote it. But why is the variable name `text-mode-hook` also quoted? The variable names we use with `setq` aren't quoted!

There's a good and sensible reason, but I won't try to go into it here (Chassell explains it in "Text and Auto-fill" in the *Eintr* manual): for now, you'll have to just take this as a magic incantation that placates the Emacs gods. So when using `add-hook`, quote both the name of the Hook, and the name of the function you're adding to it.

By the way, the extra work that `add-hook` does for you that plain `setq` wouldn't is that it only adds the function to the Hook's list of functions if it's not already there (so that the function doesn't run twice!).

Please note that you can set Hooks from Customize, and you should generally prefer to do so. But as your Elisp skills grow, you might find it awkward to edit a multi-line lambda expression in a hole in a form.

Defining Key Bindings

Defining Key Bindings is the big lacuna in the Customize Facility, but your Init File is here for you. Let's bind `display-line-numbers-mode` to a key so you can more easily toggle it on and off. We'll use the mnemonic `C-c l` for our keystroke (see *Bind It To a Key* for more on this choice). If we want our new binding to work everywhere, then we want to use `keymap-global-set` according to this pattern:

```
(keymap-global-set "C-c l" 'display-line-numbers-mode)
```

By now you won't be surprised that you have to quote the function (`display-line-numbers-mode`) that you're binding. But what's up with `"C-c l"`?

This is one of many ways you can "spell" a key binding. The `keymap-global-set` function takes a string that specifies the binding in the same way that Emacs talks about it. So think of your desired binding, and then ask Emacs how it's spelled, and use that.

Suppose you want to bind `display-line-numbers-mode` mode to a function key instead—perhaps F7. But how do you spell "F7"? Just ask Emacs: invoke `C-h c` (`describe-key-briefly`) and when prompted for a keystroke, hit that key. You'll see in the Echo Area that Emacs spells it `<f7>`, so you'd use `"<f7>"`.

Remapping Commands Sometimes you want to replace a command that's already bound to one or more keystrokes with an alternative command that you prefer. Suppose you've installed an alternative to Dired, say `neo-dired`[339], for directory editing. `C-h w` (`where-is`) tells me that `dired` is bound to three keystrokes[340]: `C-x C-d`, `C-x d`, and `<menu-bar> <file> <dired>`. We can change the binding of `C-x C-d` with this expression:

[339] I just made that up...

[340] Technically, three *events*...

```
(keymap-global-set "C-x C-d" 'neo-dired)
```

but now we have to do two more. Instead, we can change all the `dired` bindings with this single expression:

```
(keymap-global-set "<remap> <dired>" 'neo-dired)
```

Disabling Commands As discussed earlier, Emacs starts with some commands (thought to be confusing to newbies) disabled by default. While I think you'll eventually enable all these commands, you might

actually want to *disable* some other commands that you find annoying.

For example, `suspend-frame` is bound to `C-z` and `C-x C-z` and "iconifies" an Emacs Frame (when running in graphical mode). What "iconification" actually does is up to your window manager; usually it minimizes the Frame. Since I use a tiling window manager, this command is useless to me and actually has an annoying effect. I don't want to accidentally invoke it, so I disable it like so:

```
(put 'suspend-frame 'disabled t)
```

You can use this as a recipe; be sure to imitate the quoting style.

Disabling the command has the advantage of allowing you to still use it on rare occasions.

Un-binding Commands A less extreme version of this might be to not actually disable a command, but just remove the key binding by which you accidentally invoke it. You can do this by binding a key to the special symbol `nil` like this:

```
(keymap-global-set "C-z" nil)
```

After this, `C-z` will just beep at you, but you can still invoke the command that was previously bound to `C-z`, without going through the elaborate Disabled command dialog, with `M-x suspend-frame`. See "Key Bindings" in the *Emacs* manual for more information..

Test Your Init File Modifications!

After every Init File tweak, you should immediately do a test to make sure you haven't introduced an error! This is especially so if, as I recommend, you run the Emacs Server, which implies that it may be a long time before you next restart your Emacs. If it's been weeks since you tweaked your Init File, an error at startup time will be all the more puzzling.

After saving your tweaked Init File, just do this:

```
M-x async-shell-command RET emacs --no-desktop --debug-init
```

This fires up a fresh Emacs (without bothering with all the files in your current desktop); if it pops up with no errors, you've passed the first test! You should also test the new functionality you added to see if, in addition to not blowing up with an error, it also actually does what you expect! Then just do `C-x C-c` (`save-buffers-kill-emacs`) to exit and breathe easy. (Some classes of bugs won't reveal themselves this early in the game, but you might as well eliminate the ones that will.)

If you *have* made a mistake that generates an error, the `--debug-init` option will pop up the Debugger; even without Elisp debugging skills, this should help you determine where your error is—and anyway, you know it's got to be in the tweak you just made! Use `q` (`debugger-quit`) to quit out of the Debugger, and `C-x C-c` to exit the test Emacs, and see if you can fix your bug (in the original Emacs where you were editing your Init File). See "Debugger" in the *Elisp* manual for details on the Elisp Debugger.

Defining Your Own Commands

One common reason for writing a program is to automate a repetitive editing task. Many such tasks are ad hoc and unique to one situation. Keyboard Macros are often ideal for this: they're easy and fast to write, so you don't feel bad about throwing them away when you're done.

But for more complex tasks, you'll need a real programming language, and since you're living inside of a Lisp Machine, of course you'll choose Emacs Lisp.

Now, I can't teach you to program in one chapter, but you *can* learn if you want to, and Robert Chassell's *An Introduction to Programming in Emacs Lisp* is the perfect choice. It starts from scratch, uses Elisp, the programming examples are Emacs-oriented, and the entire book can be read in Info, while you write, test, and debug your programs in Emacs.

If you're already a programmer—especially if you know another Lisp (like Common Lisp or Clojure)—you can skim through Chassell or dive right into the Elisp manual.

What I *can* do in this chapter is give you a taste of what Elisp programming feels like. We'll implement a realistic but simple new Emacs command, one that I, at least, actually find to be useful.

A Missing Command

What with the 6,239 interactive commands that Emacs starts out with, you might be surprised to discover you need one that doesn't already exist. I wanted to be able to jump to a random Buffer line, and couldn't find a command to do it. Such a command would fit among the Goto commands on the `M-g` prefix (`M-g M-g` (`goto-line`), `M-g c` (`goto-char`), and friends). Myself, I'd bind it to `M-g M-r`.

So of course I wrote it and added it to my Init File, and now I can `M-g M-r` whenever I want.

What use is such a command? I frequently have lists of things in my Emacs: some are generated by Emacs (like the Buffer generated

by `M-x list-colors-display`) and some I maintain in files myself — lists of songs or books or movies to watch, for example. Some of these lists have hundreds of lines, and sometimes it's easier to have Emacs pick a candidate, rather than having to scroll through them, staring until my eyes glaze over. (I can't be the only person who needs this; there are dozens of web sites that let you paste in your data and will then pick a line at random for you — while you gaze at their ads and they gather your personal info from the data, I presume.)

An Implementation

Here's what I wrote. Let's dissect the parts to see what makes Elisp code, and an Emacs command, tick.

```
;;; this is my new command
(defun kw-goto-random-line ()
  "Go to a randomly chosen line in the current buffer."
  (interactive)
  (goto-line (+ 1 (random (count-lines (point-min) (point-max))))))
```

The first thing you'll notice, probably *especially* if you're a programmer, is all the nested parentheses; this is a hallmark of all members of the Lisp family.[341] Don't worry about it: `emacs-lisp-mode` makes it very easy to keep track of all the parens when you're editing code.

Amounts of whitespace (except in string literals) are not significant in Elisp[342]; you could write the whole function on one line to be perverse. Lispers use a standard indentation style which is understood by `emacs-lisp-mode`, so you barely have to do anything other than hit return in order to have your function indented conventionally.

[341] Non-Lispers think LISP stands for "Lots of Irritating Superfluous Parentheses". Yawn.

[342] Contrasted with Python, for example.

Comments

My code starts with a comment on the first line:

```
;;; this is my new command
```

Elisp comments start with a semicolon and continue to the end of the line; it's conventional, but not mandatory, that whole-line comments start with three semicolons (some people prefer two). Comments are very useful in general, and are to be encouraged, but this comment is just a demonstration; it's completely pointless. For one thing, it tells the reader nothing useful. It would also be pointless to use it to describe what the function does—the usual reason for such a comment in most languages—because the *docstring* (see below) does that for us.

Naming Things

We're looking at a *function definition*: `defun` stands for "define function". For the name of this function I chose `kw-goto-random-line`. Elisp functions need fairly long, descriptive names. Since there are 22,054 functions in a stock Emacs, you need a long name to make it unique (there's already a standard Elisp function called `random`, for example, so that's right out). When you type them, either at a `M-x` prompt for commands, or in source code, Completion means you don't need to type the whole thing anyway, and the long names help you recognize the function you want to use amongst the Completion candidates.

I chose `goto-random-line` rather than, say, `jump-to-random-line`, just because Emacs already uses the `goto-` prefix for other related functions. Finally, I used my *personal namespace*, `kw-`, at the very beginning: Elisp doesn't have real namespaces, so we use package name prefixes as a hack[343], and every Emacs user (who programs) has their own personal prefix they use to namespace their personal functions.

[343] For example, all `dired` functions begin with `dired-`.

You might be surprised that I'm allowed to use hyphens in my function name[344]; this isn't allowed in most programming languages because it would be taken as a chained subtraction of four variables. In most programming languages, underscores are used instead of hyphens, but because of Lisp's unique syntax, you can use almost any character in a name. In Lisp, hyphens are to be preferred over underscores.

[344] Though you've already seen hundreds of function names with hyphens in this book: all the `M-x` commands are functions, of course.

Function Parameters

The `()` after the function name is the *formal parameter list*; this function doesn't have any parameters, but the empty parens are still required.

The Docstring

We know that all (good) Emacs commands have documentation that you can look up in the Help system (and that goes for non-command functions too). This documentation is a part of the function definition called the *docstring*. Most modern programming languages have docstrings (they were invented in the TECO implementation of Emacs in 1976), though often only as a distinguished form of comment extracted by a post-processor; in Elisp, docstrings are actually attached to the symbol that names the command, which is what makes the Help and Apropos systems possible.

A good docstring starts with a one-sentence summary of the be-

havior of the function. It can be much longer than that: many paragraphs, if necessary, and Elisp defines a markup language for docstrings that supports hypertext links to related functions, variables, documentation, and the like.

Commands Must be Interactive

While all Emacs commands are functions, not all functions are commands. Commands are functions intended to be called *interactively*: that is, invoked explicitly by the user, via `M-x` or a key- or mouse-binding. Non-command functions, on the other hand, are intended to be called indirectly by other commands or functions.

Why not let all functions be invoked by the user?[345] The main reason is because it results in a better user experience; otherwise, the Completion space would be expanded at least four-fold, and it would diminish the utility of `M-x apropos-command`, forcing you to plow through many functions that you're never going to invoke directly.

So, unless you mark a function as a command, you can't invoke it via `M-x` or a key binding. The *special form* `(interactive)` marks a function as a command, and it has to come immediately after the docstring in the function definition.

The remainder of the `defun` is the code that actually implements our command. To summarize, the overall shape of any Elisp command definition looks like:

```
(defun COMMAND-NAME (PARAMETER ...)
  "DOCSTRING.
MORE DOCUMENTATION..."
  (interactive)
  (IMPLEMENTATION CODE))
```

The Algorithm

So how can we implement jumping to a random line in the Buffer? We know how to jump to a *specific* line: just call `M-x goto-line` with the number of the line we want to jump to. So what if we just call `goto-line` with a *random* number? That's not quite right: about half of the random numbers are *negative* numbers, and those are not suitable to use as line numbers. So we need a *positive* random number — but even that's not quite right: there are a lot of positive random numbers out there, and most of them are bigger than the number of lines in any given buffer.[346]

So really, we want a random number greater than 0 and less than or equal to the number of lines in the current Buffer. Given that, we can just pass it to `goto-line` and we're done.

[345] Actually, all functions *can* be invoked by the user, *e.g.* via `M-:` (`eval-expression`), which lets you invoke arbitrary Elisp expressions from the Minibuffer.

[346] There are 2,305,843,009,213,693,951 possible positive integers in Elisp. (Okay, more, actually...)

Every programming language has functions to generate random numbers, but how do we figure out how to do that in Elisp? The Apropos system will do the job: `M-x apropos RET random RET` lists seven candidates[347] and we can easily spot the obvious one: `random`. Alternatively, we can pop into the Elisp manual in Info, invoke `i` (`Info-index`) and give it "random" and be taken directly to §3.10 Random Numbers, which describes the `random` function in detail. Most significantly, we see that we can give `random` an optional integer parameter *LIMIT*, which causes `random` to return a number from 0 to $(LIMIT - 1)$.

[347] Or 50-odd, if you've loaded the optional packages that I have.

We also need to know how to find the number of lines in the current Buffer, so that we can pass a suitable upper-bound to `random`. The same documentation-searching techniques with Apropos or the Manual will lead us to the function `count-lines`.

So our algorithm is: count the lines in the Buffer, get a random number in that range, and pass it to `goto-line`.

The Actual Code

Finally, we get to the actual code that implements our algorithm. After the `(interactive)` in our defun, we place one or more Elisp *expressions*[348]. (The value of the last expression in the defun is returned from the function, but the returned value of an interactively-invoked command is ignored.)

[348] No expressions at all are also valid, but can only implement a function that does nothing: what programmers call a *no-op*.

Our implementation is a one-liner: four nested function calls. In most programming languages, a *function call* looks much as it does in mathematical notation. To call a function f with the arguments x and y typically looks like $f(x, y)$. This is a *prefix notation*—the function name precedes its operands—to be distinguished from the *infix notation* used for common binary operators like $+$, $-$, $\times$, and $\div$.

But Lisp uses *fully-parenthesized Polish prefix notation*[349], in which the function call would look like `(f x y)`. We just move the left parenthesis to the left of the function name. Additionally, we don't need to use commas to separate the arguments: just whitespace. Our expression:

[349] Invented by the Polish logician Jan Łukasiewicz in the 1920s.

```
(goto-line (+ 1 (random (count-lines (point-min) (point-max))))))
```

in traditional notation would look something like:

```
goto_line(1 + random(count_lines(point_min(), point_max()))) ; this is NOT Elisp
```

Polish prefix notation implies that even functions that are typically written as infix operators are written in prefix form: instead of $1 + x$ we write `(+ 1 x)`. Prefix notation is more consistent, allows us to use any characters in our function and variable names, doesn't require us

to memorize operator precedence rules, and has deeper advantages as well.

Step 1 in our algorithm is to call `count-lines`. `C-h f count-lines` tells us that we need to give it two parameters:

```
(count-lines START END)
```

because it's a general purpose function that counts the lines in the Region bounded by `START` and `END`, which are character positions in the Buffer, i.e. possible values of Point. For `START` we need the position of the beginning of the Buffer, and for `END` that of the end of the Buffer. The function `point-min` gives us `START`[350], and `point-max` gives us `END`. Neither of these functions takes any parameters, so putting them together gives us:

[350] This will usually be `1`, which we could have written instead of `(point-min)` — unless the buffer is *narrowed*: `(point-min)` takes narrowing into account, and so is the correct code.

```
(count-lines (point-min) (point-max))
```

the result of which is the value we want to pass to `random`.

There's a wrinkle: a careful reading of `random`'s documentation tells us that, given a numeric parameter as a limit, it will return a random number from 0 to *one less than* the limit. (Counting from zero makes programmers happy and is very common.) There's really no line 0 in a Buffer, and if our random number can never be the last line in the Buffer, then our function is *biased* against the last line.

Fortunately we can easily fix both of these problems by just adding 1 to the number of lines! The number is still random: we've just adjusted its range:

```
(+ 1 (count-lines (point-min) (point-max)))
```

All that's left is to pass this adjusted random line number to `goto-line`:

```
(goto-line (+ 1 (random (count-lines (point-min) (point-max)))))
```

That's our complete function; let's take a look at it again:

```
(defun kw-goto-random-line ()
  "Go to a randomly chosen line in the current buffer."
  (interactive)
  (goto-line (+ 1 (random (count-lines (point-min) (point-max))))))
```

We can test it with `M-x kw-goto-random-line`.

Bind It to a Key

For some custom commands, we might be done at this point. `M-x` is good enough for commands that are only occasionally invoked. But my use case for this command is to invoke it in a long Buffer, and if

I'm not inspired by the line I land on, to invoke it again immediately, and perhaps repeat the process a dozen times until serendipity solves my decision-making problem—kind of like the way John Cage or Philip K. Dick used the *I Ching* in their music composition or writing.

In other words, I want to bind my new command to a keystroke for easy invocation. This means I need to pick a key sequence. I can either come up with an unused one, or steal the existing binding of some command I don't I think deserves it. (It's completely fine to change standard key bindings: you're just turning Emacs into your ideal editor.)

Appendix D.2, Key Binding Conventions, in the Elisp manual, addressing the authors of Elisp packages, says:

> Don't define 'C-c LETTER' as a key in Lisp programs. Sequences consisting of 'C-c' and a letter (either upper or lower case) are reserved for users; they are the **only** sequences reserved for users, so do not block them.

When you're defining a command in your Init File, *you're* the user, so those 52 `C-c` *LETTER* key sequences are available to use for your own commands. But for this command, I'm going to put it on the `M-g` prefix along with the other `goto-` commands. The `M-g` prefix only has nine bindings out of the box, which gives me a wealth of available bindings to choose from. I think the felicitous and mnemonic binding `M-g M-r` is perfect. Here's the command that goes in our Init File:

```
(keymap-global-set "M-g M-r" 'kw-goto-random-line)
```

References

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The Emacs Community

There's a vibrant, friendly, and helpful global community of Emacs users, including the volunteers who maintain the source code and are constantly fixing bugs and making enhancements.

Project GNU

GNU Emacs is part of the GNU project (GNU's Not Unix!) and has its home there. You can go there for the official download page, web versions of the documentation, and more.

The GNU Emacs FAQ

The official Frequently Asked Questions (FAQ) list is available in Emacs via `C-h C-f` (`view-emacs-FAQ`).

The Emacs Wiki

If the FAQ doesn't answer your question, your next stop should be the community-supported Emacs Wiki; it's loaded with tips, tutorials, opinions, examples, and Elisp code. Try the Emacs Newbie page. Of course it works great with EWW: `M-x eww RET https://www.emacswiki.org/`.

Mailing Lists

There are many Emacs mailing lists you can subscribe to. The two most important are probably:

info-gnu-emacs a read-only list of official announcements from the Emacs maintainers

help-gnu-emacs you can post questions to this list and the list members will be happy to try to help you out

Web Sites and Blogs

There are innumerable independent web sites and blogs devoted to Emacs; for one stop shopping, go straight to Planet Emacslife, a feed aggregator covering over 200 Emacs blogs. If you can only read one blog on a regular basis, I'd have to recommend Sacha Chua's indispensable *Emacs News*.[351]

[351] How does she do it?

Github

The last time I checked (2024), there were 6,253 public Github repositories tagged with "Emacs".

Videos, Screencasts, and Podcasts

There are scads of Emacs videos and podcasts, available in the usual places. Try Emacs Screencasts in the Wiki for a starting point.

IRC

You can easily chat with actual humans (one assumes...) about Emacs on Internet Relay Chat (IRC).[352] Project GNU says:

> There are several IRC channels dedicated to discussion around Emacs on the Libera.Chat network. Use #emacs for general discussion about Emacs, #emacs-beginners for Emacs beginner help, and #emacs-til ("today I learned") for sharing Emacs tips and tricks. See also our rules and guidelines for the official GNU and FSF IRC channels.

[352] Via your preferred Emacs IRC client, of course.

EmacsConf

> EmacsConf is the conference about the joy of Emacs, Emacs Lisp, and memorizing key sequences. — `https://emacsconf.org/`

There's been an occasional (verging on annual) free Emacs conference since 2013. You can watch the videos of past talks and download papers and such from the conference web site.

Part III

NEVER LEAVE EMACS: APPLICATIONS

In this part of the book we discuss major Emacs *applications*: Modes and subsystems that either replace the other applications most computer users need, or provide Emacs front-ends to them.

Some topics that could be considered Emacs applications are discussed elsewhere; for example:

archivers see *Archive Files*

document readers see *Info: The Emacs Documentation Reader* and *Document Files (PDFs and the Like)*

file managers see *Directory Editing with Dired*

file pagers, `tail -f` see *Read-Only Buffers, or, Emacs is More* and *Auto-Reverting (Watching Files)*

file searching tools see *Meet the Greps*

image viewers see *Image Files*

printing utilities see *Printing*

remote logins and shells see *Remote File Editing with Tramp*

spreadsheets see *Org Mode*

External Commands, Shells and Terminals

There is a world outside of Emacs, and sadly we must occasionally interact with it directly.

Emacs provides indirect, smooth and transparent access to the outside world through interfaces like the `grep` family of search commands, the `vc` family of version control commands, and many more — you might well use commands like these without even knowing that they're interfaces to external commands.

But we still need to run the occasional *ad hoc* external command that no one has yet written an interface for. Emacs provides many ways to do this.

Running One Command

If you just need to run one command, you can use `M-!` (`shell-command`). It prompts you for a command[353], runs it *synchronously*, and shows you the command's output (standard output and standard error combined).

For example, if you want to know the date and time[354], you could say `M-!`, type `date` at the "Shell command:" prompt, and hit return. This runs the standard Unix command `date`.

As the name `shell-command` and its prompt implies, it uses the shell to run this command, so you can use shell metacharacters, file globs, redirection, pipes, etc.

Already, even with such a simple command, several questions are raised.

[353] You can use `TAB` completion on both the command name and any filename arguments.

[354] You can have the time of day (and the system load average) displayed in the Mode Line by putting `(display-time)` in your init file.

Which shell is being used?

Emacs tries hard to use "your shell" when executing external commands. If your shell is `bash` or `zsh` or any Posix-compliant shell, it'll be fine. If your shell is an exotic, not-so-Posix, shell, like say `fish` or `rc`, you may or may not have problems. If you do, try setting `shell-file-name` to `bash` or `sh` in your init file[355].

[355] `(setq shell-file-name (executable-find "bash"))`

Where's the output?

If the command ran successfully but produced no output at all, you'll see the message "(Shell command succeeded with no output)" in the Echo Area. For example, you might remove a file by saying, `M-! rm FILENAME`[356]. Since `rm` is usually silent, Emacs will report the message above. You can try this with the harmless command `M-! true`, which does nothing but succeed, and produces no output.

If the command failed[357] silently, you'll instead see the message "(Shell command failed with code 1 and no output)"; try `M-! false` to see this.

If the command produces output (whether to stdout or to stderr), Emacs pops up a Buffer named `*Shell Command Output*` which contains it. You can do what you like with this: gaze upon the output before deleting the Window or killing the Buffer, jump to the Window to copy some of the text[358], or edit the output to get it into shape for some other purpose.

However, if the command produced only a small amount of output[359], it will be inserted into the `*Shell Command Output*` Buffer as above, but the Buffer won't be popped up; instead the output will be shown in the Echo Area. (You can still switch to the output Buffer to grab the text.) So `M-! date` seems to have the effect of just showing the date and time in the Echo Area.

[356] It's probably nicer to use `M-x delete-file` instead, which has some extra features. (It's tricky to come up with good examples of external command usage because for most common possibilities, Emacs provides a better native way to do it!)

[357] I.e. terminates with a non-zero exit status.

[358] There's a better way; see below.

[359] By default, less than 1/4 of the height of the current frame; this is `max-mini-window-height`.

What happens to the output Buffer if I do `M-!` twice?

By default, if the `*Shell Command Output*` Buffer already exists, its contents are erased before the next `M-!` uses it. If you'd prefer that subsequent `M-!` commands append to this Buffer, you can change this in your init file[360]. If you only occasionally want to keep the old contents around, you can also rename the Buffer before the second `M-!`.

[360] `(setq shell-command-dont-erase-buffer t)`

What do you mean, synchronously?

When I say that `M-!` runs the command *synchronously*, I mean that Emacs waits until the command finishes: if the command takes a noticeable amount of time to run, Emacs will appear to freeze up, and you can't type or execute commands. This is a usually a good thing, because it means that you can't, say, accidentally save a file that would affect the running command: synchronous execution is easier to understand and so the effect is more reliable. Try running the command `M-! sleep 60` and you'll have to wait one minute before Emacs comes back to you: that's synchronous execution.

Of course, you can always interrupt and terminate the external

command. You've probably guessed that you do this the same way you interrupt an internal Emacs command: just hit `C-g` (`keyboard-quit`) — try it with `M-! sleep 60`. This is exactly the same as Control-C'ing a command in the shell: Emacs sends a SIGINT signal to the process.

If you're a Unix programmer, you know that external commands are allowed to ignore SIGINT. If you hit `C-g` *twice*, Emacs sends the unignorable SIGKILL signal to the command.

Isn't there an easier way to insert command output?

A common reason to run an external command is to grab its output to insert in some Buffer. Rather then micromanaging Buffers and Windows by switching to and from the output Buffer and copying and pasting text, you can directly insert the output of the command into the *current* Buffer (at Point) instead, just by giving `M-!` a prefix argument. So, if you want a time-stamp in the current Buffer, you can say `C-u M-! date`.

What about standard input?

By default, the standard input of the external command is redirected to come from `/dev/null`. You can see this by running `M-! cat` — this command terminates immediately with no output instead of waiting for input, the way it would in the shell. In other words, Emacs effectively runs `cat < /dev/null`.

Sometimes you instead want to use part of a Buffer as the input to the external command. You could of course tediously copy the text to a temp file and say something like `M-! tr a-z A-Z < /tmp/myfile`, but there's a much easier way. Just set the Region around the text you want to feed to the command and use `M-|` (`shell-command-on-region`) — that's a pipe, not an exclamation point.

Perhaps you want to know how many words are in the previous paragraph. Just set the Region around the paragraph with `M-h` (`mark-paragraph`) and say `M-| wc -w` and you'll see the answer in the Echo Area (there are 80)[361].

Sometimes you want the output of the external command to actually *replace* some text in your Buffer; giving `M-|` an argument will do this. For example, if you just typed a whole paragraph of an email in which you really wanted to yell at someone but forgot to hold down Caps Lock, just set the Region around the paragraph and say: `C-u M-| tr a-z A-Z`, which will feed the paragraph to `tr`, and replace the paragraph with `tr`'s all-uppercase and shouty output[362].

[361] Of course, Emacs can directly count the words for you with `M-x count-words-region` (also on `M-=`); I said it was hard to think up examples that you need to do with external commands!

[362] But again, you'd really do this with `C-x C-u` (`upcase-region`)...

Can I run any program this way?

I'm afraid that fully answering this question requires us to enter rather deeply into the Unix weeds[363]. You can run any *classic Unix command-line application*, keeping in mind that if it reads from standard input, you need to redirect stdin from a file, as in:

```
M-! tr a-z A-Z < /etc/passwd
```

or from the current Buffer, as with `M-|`: you can't expect to provide input by typing at the program (but see *Interactive Shells* below).

You *can* fire up GUI programs that don't use the terminal, like, say, `firefox` (best done asynchronously; see *What if I don't want to wait?*).

But you can't necessarily run every program that prompts a human for input (from `/dev/tty`, a.k.a. The Terminal) with `M-!`, or `M-|`. Some such programs may work with `M-&`, but it's highly dependent on how exactly they use the terminal[364]. There aren't a lot of Unix command-line programs that ask questions and expect answers, but there are a lot that allow for single-character input. Many so-called *Curses applications* fall into this category: programs like `top`, `htop`, `vi`, `vim`, `less`, `more`, `mutt`, and many more.

Additionally, most Curses applications also *address the screen* i.e. clear the screen, move the cursor around — up and down and left and right — as an animation perhaps, or the way `vi` lets you move the cursor with the `hjkl` or arrow keys. Even if they don't ask for input, these programs won't work successfully because cursor addressing requires a *terminal emulator*[365]. If you try to run such a program, the output (consisting largely of what we call *escape sequences*) will look like garbage.

The good news is:

1. Emacs implements native versions of many of these kinds of Curses programs; instead of `top`, use `proced`; instead of `mutt`, any of Emacs's mailers; instead of `less`, `M-x view-mode`; instead of `vim`, Emacs with `M-x evil-mode`; and so forth.

2. If you really want to run `vim` (!) or `top` or `mutt` inside Emacs, you can; you just can't use `M-!` to do it; see *Terminal Emulation* below.

What if I don't want to wait?

While synchronous execution is often a good thing, sometimes you want to run a command asynchronously — what if you want to fire up a PDF viewer for example, as a background process[366]? You don't want Emacs to be frozen until you're done reading.

All you need to do in this case is run `M-&` (`async-shell-command`). Unlike `M-!`, after `M-&` Emacs doesn't freeze because it's not waiting for

[363] And frankly, I have no idea how this issue translates to Microsoft Windows.

[364] For those familiar with Unix system calls, a program that opens the terminal in *cooked mode* and flushes properly may work, but *raw mode* programs probably won't work at all.

[365] But guess what? Emacs has a terminal emulator. Several. See below.

[366] Emacs can display PDFs itself, but I'll admit that an external PDF viewer might occasionally be a better choice.

the command to finish; you can continue working[367].

[367] Alternatively, you can use `M-!` but append an ampersand `&` to the command — the same thing you'd do in the shell; there's no difference between these two approaches: `M-&` just appends the ampersand for you.

The output Buffer in this case uses a different name: `*Async Shell Command*`. There's one big difference between this Buffer and the synchronous `*Shell Command Output*` Buffer: the background process is *connected* to the `*Async Shell Command*` Buffer. This means that if you kill that Buffer, Emacs will kill the background process associated with it. It will ask permission first:

```
Buffer "*Async Shell Command*" has a running process; kill it? (yes or no)
```

Also, if you terminate Emacs itself, all running async processes that Emacs started will be killed. It will display a list of these processes and ask you first: "Active processes exist; kill them and exit anyway? (yes or no)".

If you instead terminate an asynchronous command outside of Emacs (that PDF viewer probably has a quit command), Emacs will notice and mention this in the Echo Area (e.g. "pdfviewer filename.pdf: finished.").

Since async commands tend to stick around for a long time, if you run a second `M-&`, Emacs will ask:

```
A command is running in the default buffer.  Use a new buffer? (yes or no)
```

If you don't want to wait for the previous command to terminate, you should say "yes". Really, I've never had a reason to answer this question with "no". Also, most of the commands one typically runs asynchronously don't produce any useful output, so the fact that the `*Async Shell Command*` Buffer is always popped up is kind of annoying. I recommend the following settings for your init file:

Init File

```
(setq async-shell-command-buffer 'new-buffer) ;multiple async commands ok!
(setq async-shell-command-display-buffer nil) ;don't pop up the buffer
```

Managing Asynchronous Processes

If you fire up a number of asynchronous processes in a long running Emacs, you might want to check on them and see what state they're in.

`M-x list-processes` pops up a Buffer listing all the asynchronous processes of which Emacs is the parent. It might look like this:

```
Process     PID     Status  Buffer                TTY          Thread Command
OCaml       447866  run     *OCaml*               --           Main   ocaml -nopromptcont
Shell       3779765 run     *Async Shell Command* /dev/pts/0   Main   /bin/zsh -c llpp web/emacs-tutorial.pdf
compilation 418697  run     *compilation*         /dev/pts/6   Main   /bin/zsh -c make clean check
ielm        941277  run     *ielm*                /dev/pts/4   Main   hexl
ispell      1495152 run     --                    --           Main   aspell -a -m -d en_US --encoding=utf-8
server      --      listen  --                    --           Main   (network server on /run/user/1000/emacs/server)
shell       274144  run     *shell*               /dev/pts/5   Main   /bin/zsh -i
```

You can find your `M-&` commands by looking in the `Command` column.

The `Buffer` column contains clickable links that take you to the Buffer of the command; you can thus access any output the process has produced. In addition, if you issue the command `d` (`process-menu-delete-process`) it will kill the process on that line, and `g` (`revert-buffer`) will update the `list-processes` Buffer to reflect any changes in the state or existence of the processes (running `M-x list-processes` again has the same effect).

For example, if you say `M-& sleep 60` and then `M-x list-processes`, you will see your command listed; if you type `g` within 60 seconds, it will still be there, but if you type it after 60 seconds, your process, which will have terminated, will be gone from the list.

You may notice processes in this list that you didn't start with `M-&`. These are processes that Emacs starts for you in response to various commands. In the above, you can see, from top to bottom:

- an interactive REPL for the OCaml programming language
- an external PDF viewer (`llpp`)
- a compilation in progress (`make clean check`)
- an interactive REPL for Elisp (`ielm`)
- the spelling checker (`aspell`)
- a `network server` process (which is due to my running this Emacs in Server Mode)
- an interactive shell that I'm using (`zsh -i`)

The only one of these processes that I invoked with `M-&` is the PDF viewer.

Run Commands from Dired

Another way to run an external command is from a Dired Buffer. This is great if you already happen to be in Dired, but if you're about to run a command on several files, it'll often be worth your while to pop up a Dired Buffer first. This lets you pick and choose the files in various ways when a simple file glob isn't enough. The dozens of basic Dired commands let you do standard file management with a single keystroke (delete, rename, copy, etc), but Dired also has powerful ways to run arbitrary programs on precisely selected sets of files, synchronously, asynchronously, or in parallel. See *Running External Commands* in Dired.

Interactive Shells

If you anticipate the need to run a whole sequence of shell commands in the near future, you might as well fire up a shell! `M-x shell` will pop up a new Buffer with your shell running in it, in the directory of the Buffer in which you invoked it (so, if you're editing a file, the shell comes up in the directory of that file); the Buffer is in a special Major Mode, `shell-mode`.

You can now use that shell much as you would in a terminal. Type commands at the prompt, hit return, and see the output. There are advantages and disadvantages to running your shells in Emacs; the advantages are substantial.

`shell-mode` Advantages

First and foremost, `shell-mode` implements an editable transcript of your entire session. Shell Buffers subsume the features of fancy terminal programs and add-on terminal multiplexers like tmux and screen, but with the advantage of using native Emacs features and key bindings that you already know, which are in sum far more powerful than any given terminal, and which are completely customizable and extensible.

- Say goodbye to pagers like `less` and `more`! Never again will you need to pull up the previous command just to append `| less` to it (and then pointlessly re-run it!). Just use any Emacs scrolling or motion commands to view any of the output in this session (but especially see `C-c C-r` (`comint-show-output`)). This is of course like using the scroll bar in a terminal, but far more precise, and once you get where you're going:

- you can easily copy and paste or even edit in place any of the output;

- or open any filename or URL in the output without copy-pasting, retyping, or mousing (just use `M-x find-file-at-point`, `M-x browse-url` or the like);

- or zap uninteresting previous output with a keystroke (`C-c C-o` (`comint-delete-output`));

- and rather than scrolling, you can search back through any of the output in this session with all the power of incremental search and `M-x occur`.

You can do any of these things while the program is running and generating more output.

Parenthetically, it should be noted that `shell-mode` is a descendant of `comint-mode`, from which many Emacs interactive modes are made (such as most programming language REPL modes), so many of the above advantages also accrue to any `comint` Buffer (with the same key bindings).

Command History

`shell-mode` implements its own command-line history operations in place of your shell's (though you can link the two histories together); these commands are tightly integrated with Emacs.

If you're at the shell prompt, a sequence of `M-p` (`comint-previous-input`) (or `<C-up>`) commands will pull up your previous shell commands in place, at the prompt; `M-n` (`comint-next-input`) (or `<C-down>`'s) will change direction. (In most shells, plain up- and down-arrows do this, but in a Shell Buffer, these are the normal Emacs cursor-motion commands, so they actually move within the Buffer (i.e., within the transcript), as do `C-p` and `C-n`).

But you can also move back in the transcript to previous commands at their original prompts with `C-c C-p` (`comint-previous-prompt`); when you do this you can see the command's output in context (`C-c C-n` (`comint-next-prompt`) goes the other way.)

Re-running Commands If you're at a previous prompt, you can hit `RET` (`comint-send-input`) to copy that command to the prompt at the end of the transcript and resubmit (i.e., re-execute) it (you can edit it before hitting `RET`). `C-c RET` (`comint-copy-old-input`) does the same thing without submitting the command, so you can edit it at the end of the transcript instead. It's a subtle but useful distinction; try both to see what I'm talking about.

In fact, with `RET` and `C-c RET` you can re-run shell commands that appear in the *output* of shell commands: in other words, you don't have to be at a previous shell prompt. So if you do `cat README` and the `README` file contains a shell command like this:

```
This command prints a Coordinated Universal Time (UTC) timestamp in
ISO 8601 format:

    env TZ=Zulu date +%Y-%m-%dT%H:%M:%SZ

and here's why.
```

---

you can execute that shell command without cutting-and-pasting: just position Point anywhere in that line and hit `RET` or `C-c RET`, possibly after editing the command however you like.

Searching Command History There are two ways to search your command history. If you just search backward with `C-r` (`isearch-backward`), you will search back through the transcript, and when you find your way to the command you want, you hit `RET` or `C-c RET` as just described. This involves searching past false matches in the output of previous commands, so you can instead search the history of commands in place, like a conventional shell in a terminal, at the latest prompt at the end of the transcript, with `M-r` (`comint-history-isearch-backward-regexp`).

Shell Control Characters Most shells support the commands in column one of Table 52, so you may be used to them (unless you've turned on `vi` bindings!); because many of these keystrokes already have a use in Emacs, the `shell-mode` equivalents (shown in column two) are prefixed with `C-c`.

Table 52: Shell Commands

Shell	Emacs	Action
`C-a`	`C-a` or `C-c C-a`	Go to beginning of line (after prompt)
`C-c`	`C-c C-c`	Interrupt the running command
`C-d`	`C-c C-d`	Send EOF
`C-e`	`C-e`	Go to end of line
	`C-c C-e`	*Go to prompt at end of Buffer
`C-o`	`C-c C-o`	*Discard output
`C-n` or ↓	`M-n` or `C-<down>`	Retrieve the next command
`C-p` or ↑	`M-p` or `C-<up>`	Retrieve the previous command
`C-r`	`M-r`	Incremental search of command history
`C-u`	`C-c C-u`	Kill (erase) current line (back to prompt)
`C-w`	`C-c C-w`	Kill (erase) previous word
`C-z`	`C-c C-z`	Stop the running command
`C-\`	`C-c C-\`	Quit the running command
`ESC .`	`C-c .`	Insert previous final argument

Two actions (*marked) are not perfect equivalents, in order to make them more useful in an Emacs context.

`C-c C-e` goes to the end of the line if you're at the final prompt at end of the transcript, but if you're elsewhere, it jumps to the end of the transcript. Unix's ancient *Control+O* command is usually overridden or ignored in modern shells.

Manipulating the Transcript

You can edit the transcript using any commands you like, but `shell-mode` defines some convenience features.

`C-c C-r (comint-show-output)` scrolls the first line of this batch of output to the top of the Window; this is what to type if the output

of your command was too long to fit in the Window, rather than scrolling backwards imprecisely, hoping to spot the beginning of the output.

`C-c C-o` (*`comint-delete-output`*) deletes the last batch of output from the transcript (replacing it with the string `*** output flushed ***`).

`C-c M-o` (*`comint-clear-buffer`*) delete everything from the transcript except for one prompt, exactly what you see when you first run `M-x shell`.

`C-c C-s` (*`comint-write-output`*) write the output of the last executed command to a file; this is equivalent to, but nicer than, explicitly navigating to the beginning and end of the output, setting the region, and executing `C-x C-w` (`write-file`).

Directory Tracking

`shell-mode` tracks `cd`, `pushd`, and `popd` commands[368] and synchronizes the Buffer's `default-directory` with them, so as you move around in the shell, file-related Emacs commands (like `C-x C-f` (`find-file`)) will be aware of where you are (so if you type `cd /etc` and then `C-x C-f passwd` Emacs will pull up `/etc/passwd`).

[368] This assumes these commands have those exact names and behave the way they do in a "normal" shell, e.g. `bash`. If this isn't the case for your shell, you can fix it with some customizations.

Terminating the Shell

You can terminate your shell just as you would in a terminal: run the shell's exit command (typically `exit` or `logout`) or send the shell EOF, with `C-c C-d` (`comint-send-eof`). If you do this, the shell Buffer remains; it will be dead — unresponsive — but you can view it and manipulate the transcript; you can kill the Buffer when you're really done. You can also save a step and just run `C-x k` (`kill-buffer`) without properly exiting the shell; Emacs will, as usual, tell you the Buffer contains a running process, ask if you really want to terminate it, and if so, kill the Buffer.

Multiple Shell Buffers

If you've already fired up a shell, `M-x shell` will return you to that same shell Buffer, but you can have as many distinct shells as you like. If you want another one, you can either manually rename the Buffer first, or instead invoke `C-u M-x shell`, which will prompt you for a Buffer name for a brand new shell. To be precise, with no argument, `M-x shell` looks for a Buffer named exactly `*shell*` and switches to it if it exists; if no such Buffer exists, it fires up a new shell in a Buffer with that name.

An easy way to manage the common situation of one-shell-per-software-project is to use `C-x p s` (`project-shell`) instead of `M-x shell`; see *Managing Projects* for more information.

There's no one-size-fits-all way to manage a collection of many shell Buffers, so if you don't want to use the usual Buffer selection commands to choose the one you want, you'll have to explore the Package Manager, which has many third-party packages offering a choice of schemes for managing and tracking shell Buffers (none of them suited me, so I wrote my own[369]).

[369] Which also doesn't really suit me! Tough problem.

What about the memory usage of the shell Buffer?

The transcript can take up a lot of space in your Emacs. If you run a command which starts spewing output uncontrollably, it could conceivably eat up all of memory, which is annoying. Why isn't this a problem in a terminal? Simply because no terminal that I know of stores an unlimited amount of output: they all truncate it at some (probably customizable) limit (the default is often a mere 1,024 lines).

While `shell-mode` doesn't have any limit by default, you can set one (expressed in lines), and I recommend it. However, to maximize the usefulness of the transcript, I recommend setting it to a fairly sizable number. This init file setting uses the number of lines in *War and Peace*:

Init File

```
(setq comint-buffer-maximum-size 65336) ; must be able to cat War and Peace!
(add-hook 'comint-output-filter-functions 'comint-truncate-buffer)
```

`shell-mode` Disadvantages

`shell-mode` does have some disadvantages, compared to running a shell in a terminal.

- As mentioned above, you can't run raw-mode or Curses applications[370].

[370] Actually, there are third-party packages that allow this.

- `shell-mode`'s completion is simply nowhere near as good as that of `zsh` (which I think has the best completion of any shell), `fish`, or even `bash` — all of which can complete command-line options for many standard commands. Do you know all the long options for GNU `tar`? `zsh` does:

  ```
  $ tar --<TAB>
  zsh: do you wish to see all 170 possibilities (171 lines)?
  ```

  and if you hit `TAB`, will display them with documentation!

I used to think this was a major weakness, but thanks to the valiant contributors to the Emacs ecosystem, no longer! See *Recommended Third-Party Packages* for a solution.

Recommended Third-Party Packages

To get completion in `shell-mode` that's almost as good as `zsh(1)` in a terminal, install the `fish(1)` shell via your OS package manager (I'm assuming you already have the ubiquitous `bash(1)` installed), and add this code to your Init File.

```
(dolist (pkg '(fish-completion bash-completion))
  (unless (package-installed-p pkg)
    (with-demoted-errors "%s"
      (unless package-archive-contents
        (package-refresh-contents))
      (package-install pkg))))

(add-hook 'shell-mode-hook
          (lambda ()
            (when (and (executable-find "fish")
                       (require 'fish-completion nil t))
              (fish-completion-mode +1)
              (when (and (executable-find "bash")
                         (require 'bash-completion nil t))
                (setq fish-completion-fallback-on-bash-p t)))))
```

Shell Init File Tweaks

I recommend the following code snippet for your shell's init file; it's at least suitable for `bash(1)` (add to your `~/.bashrc`) or `zsh(1)` (add to your `~/.zshrc`). Remember that regardless of which shell you use in your terminals, `M-x shell` runs the shell defined in `shell-file-name`.

The `INSIDE_EMACS` environment variable will be non-empty (hence the `-n`) in subprocesses fired up by Emacs (like the shell run by `M-x shell`). We want to set `TERM` to a terminal that supports ANSI SGR color control sequences for programs that emit them (notably, `grep(1)`, `ls(1)`, and `diff(1)`) — `ansi` is fine for this. We define aliases to encourage programs to produce colorized output.

We also want to convince programs never to direct their output to a pager like `more(1)` or `less(1)` — the `shell-mode` transcript is itself the best pager; we do this by setting `PAGER` to `cat(1)`.[371]

Of course, in general we prefer `M-x manual-entry` to `man(1)`, `M-x grep` and friends to `grep(1)`, `M-x dired` to `ls(1)`, and `M-x ediff` and

[371] `man(1)` needs extra convincing; hence the setting of `MANPAGER`.

friends to `diff(1)`, but if you're in a shell Buffer you'll occasionally want to invoke these commands.

Finally, I unset a `zsh(1)` option to prevent it from invoking the Zsh Line Editor (`shell-mode` replaces that facility).

```
if [ -n "$INSIDE_EMACS" ]
then
  export TERM=ansi
  export PAGER=cat
  export MANPAGER=cat
  grep --version 2>/dev/null | grep GNU > /dev/null && alias grep='command grep --color=auto'
  ls   --version 2>/dev/null | grep GNU > /dev/null && alias ls='command   ls   --color=auto'
  diff --version 2>/dev/null | grep GNU > /dev/null && alias diff='command diff --color=auto'
  case "$0" in
  *zsh) unsetopt ZLE ;;
  esac
fi
```

Terminal Emulation

You can solve both of my claimed `shell-mode` disadvantages by using `M-x term` instead:

- you can run raw-mode and Curses applications because `term` is a full-fledged terminal emulator, just like `xterm` or any other terminal
- you get the full completion capabilities of whatever shell you use — because input is delivered a character at a time, instead of a line at a time (as with `shell-mode`), when you hit `TAB` your shell responds normally.

So now you can happily run `htop`, `mutt` — even `vim` works perfectly (if you're in a sacrilegious mood).

Thanks for wasting my time with all that stuff about `shell-mode` then!

Well, I think the combination of `shell-mode` and native Emacs interfaces to applications is superior to `M-x term`. But most of the concepts and commands from `shell-mode` apply to `term-mode` as well, if you factor in the additional complexities of `term-mode`.

Complexities?

Since `term-mode` delivers your input to the shell a character at a time, that means that you can't just type Emacs commands! If you fire up

`term-mode` for the first time, and think, "How does this mode work? I know, I'll type `C-h m` (`describe-mode`) as usual!", it won't work. The `C-h` is immediately passed to your shell (where it almost certainly deletes the character to the left of your cursor), and the `m` will then be inserted at the prompt. If you type `C-a` and your cursor goes to the beginning of the line, that's not Emacs doing it: the `C-a` went directly to your shell and your shell moved the cursor. You can't type a `M-x` command because *that* gets passed to your shell (`zsh` has its own `M-x` command, for example). Neither `<up>` nor `C-p` will move back into the transcript. You get the idea. If you're new to `term-mode` you might have a lot of trouble figuring out how to "get back to Emacs".[372]

[372] Almost as tricky as figuring out how to exit `vim`!

Obviously a shell that isolates you from all the powerful synergistic interactions of Emacs commands would be more of a liability than a help — you wouldn't be able to "use Emacs" until you quit the `term-mode` shell! — so there's a way to solve the problem.

Line Mode versus Char Mode

At any moment, the terminal emulator is one of two "sub-modes"[373]. It starts up in Char Mode, the "raw" sub-mode, in which (almost) every character is sent directly to your shell (this is indicated in the Mode Line where it says "Term: char"), but you can switch to Line Mode to make it act like `shell-mode`: almost all control characters are interpreted normally by Emacs and commands are only sent to the shell when you hit `RET`. You can toggle back and forth between these two "modes" at will:

[373] Not real Emacs "Modes"; the sub-modes are just clever manipulations of the `term-mode` major mode.

`C-c C-j (term-line-mode)` switch to Line Mode (mnemonic (for nerds): *Control-j* is ASCII "*line* feed")

`C-c C-k (term-char-mode)` switch to Char Mode (mnemonic: K for Char, or "the key next to `C-j`")

I said above that in Char Mode, *almost* every character goes direct to the shell. But obviously `C-c` is an exception, since you can use `C-c C-j`; there are several other commands on the `C-c` prefix in Char Mode, including all the `shell-mode` commands (so `C-c C-c` sends a `SIGINT`, etc). Additionally, `C-x` is an exception, so you can change Windows and suchlike easily; it has a few additional convenience bindings, like `C-x M-x` being bound to `execute-extended-command`.

Disadvantages of the Terminal Emulator

The terminal emulator is a bit of a trade-off. If you spend a lot of time in the shell running Curses programs, you'll find the terminal

emulator invaluable. But the less you do in the shell and the more you do in an Emacs-native manner (as this book is intended to encourage), the more fiddly you may find the need to switch between Char Mode and Line Mode. Additionally, `term-mode` is not well integrated with Tramp (see *Remote Shells* below), and the transcript commands (`C-c C-o`, etc) don't work as cleanly, because the shell can use escape sequences in ways that can't be perfectly predicted and coped with — the transcript can end up looking strange (this doesn't really interfere with working in the terminal, it's just wonky).

Myself, I basically don't need any Curses applications (thanks to Emacs alternatives), so I prefer `M-x shell` with it's powerful transcript and lack of `term-mode` fiddlyness.

Remote Shells

If you are editing a remote file via Tramp, any shell commands you execute, whether by `M-!`, `M-&`, `M-x shell`, or `M-x eshell` (and also `dired`), will transparently execute on the remote host. This is frankly almost miraculous when you first try it, and I feel like I'm underselling this amazing feature by saying so little about it. But what more can I say? It just works automatically. As a simple demo, open a remote file (to a Unix host for this demo) with Tramp and say `M-! uname -n`; it will display the remote hostname — *not* the local hostname! See Tramp for details.

Eshell

> Switching to Eshell marked a milestone for me: from then on I dropped all my crufty curses-based programs and switched to much more powerful Emacs alternatives. I now use Emacs everywhere to the point that it even is my window manager. Having a consistent environment well glued together really empowers you. — Pierre Neidhardt

Finally, I need to mention the exotic `M-x eshell`. `M-x shell` is brilliantly integrated into Emacs via the combination of excellent subprocess support and `comint-mode`, but taking those for granted, it's a rather simple thing: Emacs just sits between you and your shell. After hooking it up, the shell, which is almost certainly a program written in C, does all the heavy lifting of running programs, redirecting input and output, setting up pipelines, etc.

That was too easy for John Wiegley; his `eshell` is a true, native Emacs shell implemented in Elisp; it's not an external program. Its command language is a wild hybrid of Unix shell and Elisp, and has kind of amazing support for redirecting command output directly to Emacs Buffers and the like. It's well-integrated with Tramp. Not only

does it interpret your shell commands, but it also lets you run Elisp commands and mix them with shell commands! This is a really novel shell that has some very clever ideas, but as a result, it takes a little getting used to. Many people who really give it a fair trial are very devoted to it; doing that is on my TODO list.

References

Wiegley, John. 2020. *Eshell.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/eshell.html`. Read in Emacs with `M-x info-display-manual RET eshell RET`.

Browsing the Web

Probably most people spend more time in a web browser than any other application. While this book is intended to encourage you to move all of your computing life inside Emacs, I have to admit that the most unyielding application in this plan is the web browser.

Emacs has at least two viable web browsers (one built-in), but most of them don't support Javascript, which means that not all web sites are fully functional. In particular, you can forget about doing any shopping in Emacs for now.[374] But I do a large amount of my web browsing in Emacs. Many sites don't require Javascript to function (and some sites look better without it). Emacs web browsing is great for tech blogs and news sites, and in fact being Javascript-free can be a distinct advantage: 1. you'll almost never see an advertisement in an Emacs browser, and 2. browsing without Javascript is more secure (since many attacks from malicious web pages require it) and preserves more of your privacy.

[374] Another way Emacs saves you money?

Two different applications exemplify the two (current) approaches to writing an Emacs web browser:

- Emacs-w3m is a front-end to the external `w3m` text-mode browser. It's somewhat complex to install but, `w3m` being written in C, is pretty fast.
- EWW is a browser written in Emacs Lisp that's built-in and ready to run. This is the browser I use (I used to use Emacs-w3m): it works great, is completely keyboard-controllable, and when you find a web page that requires Javascript to work, one keystroke pops it open in your preferred external browser: what have you got to lose?

EWW: Emacs Web Wowser

EWW was originally implemented by Gnus author Lars Magne Ingebrigtsen: hence the silly name EWW: Emacs Web Wowser. An EWW Buffer, like that in Figure 51, is recognizably both an Emacs Buffer *and* a web page and many of your intuitive actions and keystrokes

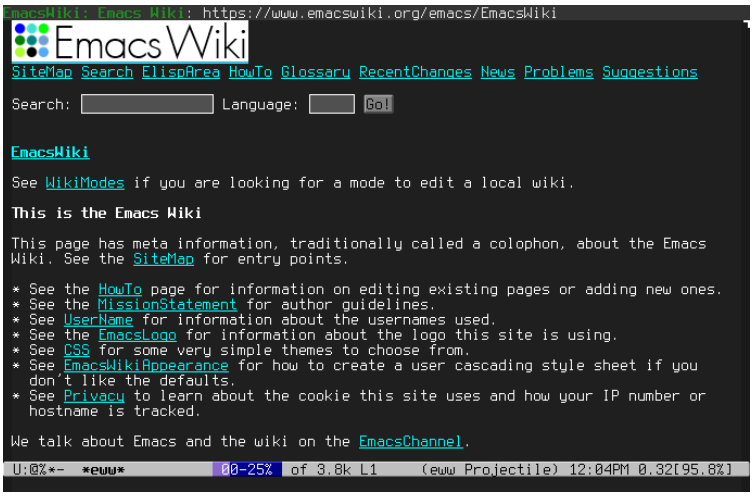

Figure 51: Browsing the Web with EWW

will work as expected: `TAB` from link to link, `SPC` to page through, and `RET` or a mouse-click to follow a link. While there's no Javascript support, EWW does handle cookies, submit forms, and display images.

But many web browser features are handled in a more Emacs-ish manner. In particular, browser tabs are Buffers. The default Buffer is `*eww*`. This is a terrible name, and I think you would prefer that the Buffer be named after the title of the web page. This is a new feature and so isn't the default; I highly recommend Customizing `eww-auto-rename-buffer` immediately. (You can instead choose to have the Buffer named for the URL.)

When you click on a link in the web page, the new page re-uses the same Buffer; if you've Customized EWW to name the Buffer after the page title, the Buffer will automatically be renamed as you follow links.. You can open a link in a "new tab"—that is, a new Buffer—if you like.

If you're using `desktop-save-mode`, all your EWW Buffers will be saved when you exit, and restored when you next fire-up Emacs. By default, the restoration of the Buffer contents is done lazily; this is because fetching and rendering many Buffers full of HTML will slow down your startup. So after restarting, when you switch to an EWW Buffer it will look empty. Just type `g` (`eww-reload`) to restore your web page. If you'd prefer to sacrifice startup speed to get all your EWW Buffers reloaded automatically, Customize `eww-restore-desktop`.

Entry Points

The main entry point for EWW is `M-x eww`, which prompts for a URL or search keywords. So you can invoke something like:

```
M-x eww RET https://www.gnu.org/software/emacs/ RET
```

or perhaps:

```
M-x eww RET gnu emacs web browsers RET
```

`M-s M-w` (`eww-search-words`) will do a web search for the contents of the Active Region or else prompt you just like `M-x eww`.

The default search engine is the privacy-focused DuckDuckGo; you can Customize `eww-search-prefix` to change that.

`M-x eww-open-file` is equivalent to giving `M-x eww` a `file://` URL (probably pointing to a file of HTML), but you don't need to type the `file://` part, and of course you'll be able to use Completion for the filename.

The command `M-x eww-list-bookmarks` let's you fire-up EWW on one of your EWW bookmarks (see EWW Bookmarks below) and you can also use URLs in the standard Emacs Bookmarks facility.

You can also invoke EWW from outside Emacs—from an external shell's command line, from scripts, or from the `xdg-open(1)` command. A suitable invocation is:

```
emacs --no-desktop -f eww-browse URL
```

This of course fires up a fresh Emacs; you can also do this via `emacsclient(1)` with a little more fiddling, which might be trickier to script[375]:

```
emacsclient --eval '(eww "URL")'
```

[375] `emacsclient` doesn't support the same `-f` option. But hey, what are you doing outside of Emacs anyway?

There are many more implicit entry points to EWW via the Browse Url subsystem. If you configure EWW as (one of) your default browsers, then you can open web pages from Dired, Email messages, `M-x find-file-at-point`, and many other places; see also Goto Address Mode.

Using the Browser

What do you do with a web page once you've pulled it up? First and foremost, you read it. You can scroll through the Buffer with the usual commands, and use Incremental Search to search within the page. Like most Emacs applications, EWW's Major Mode inherits from `special-mode` and so supports its usual helpful bindings for scrolling the Window. EWW has a wealth of its own key bindings; see Table 53.

Table 53: EWW Key Bindings

Type	Key	Action
Page Display	`F`	toggle Fonts
	`M-C`	toggle Colors
	`M-I`	toggle Images
	`E`	correct character Encoding
	`D`	toggle paragraph Direction
	`R`	Reader mode
Navigation	`<tab>`	move Point to next link
	`<backtab>`	move Point to previous link
	`RET`	follow the link at Point
	`C-u RET`	open this link in another browser
	`C-u C-u RET`	open this link in a new Buffer
	`G`	`M-x eww`
	`d`	Download the object of this link
	`w`	copy URL of link to kill ring
	`i`	browse to the Image at Point
	`C-u i`	copy URL of Image to kill ring
	`&`	open this page in another browser
"Tabs"	`C-u M-x eww`	open a web page in a new Buffer
	`M-RET`	open link at Point in a new Buffer
	`s`	switch to a different "tab" (with completion)
	`S`	list all EWW "tabs"
History	`l`	go back (Left) to previous page
	`r`	undo `l` by going Right
	`H`	list history of previous pages
Site Navigation	`n`	go to "Next" page
	`p`	go to "Previous" page
	`u`	go to this page's parent
	`t`	go to this site's Top (home) page
Bookmarks	`b`	Bookmark this page
	`B`	list EWW Bookmarks
	`M-n`	goto Next EWW bookmark
	`M-p`	goto Previous EWW bookmark
Miscellaneous	`g`	revert (reload) the web page
	`q`	quit the browser window
	`w`	copy URL of this page to kill ring
	`v`	View HTML source of this page
	`C`	view Cookies
Org Mode	`C-c C-x C-w`	translate region to org mode
	`C-c C-x M-w`	... the same

Page Display

While you're reading, you may want to change the way the display looks. You can change the fonts from variable-pitch (proportional, the default) to fixed-pitch with `F` (`eww-toggle-fonts`),[376] `M-C` (`eww-toggle-colors`) let's you choose between accepting the web page's preferred color scheme or not[377], and you can toggle images on and off with `M-I` (`eww-toggle-images`).[378]

Those of you who read languages other than English may occasionally need to correct a bogus character-set encoding with `E` (`eww-set-character-encoding`) or toggle the paragraph direction with `D` (`eww-toggle-paragraph-direction`).

The page display command I use the most is `R` (`eww-readable`), which implements the *reader mode* familiar from other web browsers. Just plain EWW is already kind of gloriously like reader mode, but `R` is great for zapping all the menus and other navigation from the top of the page. Just use `l` (`eww-back-url`) to restore the full page.

[376] I always want fixed-pitch fonts here and have Customized `shr-use-fonts`.

[377] I disable all web page color choices by Customizing `shr-use-colors`.

[378] Surprise! I like images. But a quick `M-I` can be very handy to vanish those pointless stock-photo web header images.

Navigating Links

You can navigate from link to link with `TAB` (`shr-next-link`) and `S-TAB` (`shr-previous-link`) (or any other motion or search commands!) and of course `RET` (`eww-follow-link`) will follow the link and open the new page in the same Buffer. With a single prefix argument, `RET` will open the link in another web browser (presumably external to Emacs), like `&` (below) does for the current page. With two prefix args (`C-u C-u RET`), `RET` will open the link in a new Buffer, like `M-RET` below. `G` (`eww`) lets you enter a new URL or search to be opened in this Buffer.

Instead of *browsing* the content of the link at Point, `d` (`eww-download`) will *download* it to the `eww-download-directory`, which you can Customize. If Point isn't on a link, it will download the current web page (as HTML).

When Point is on an image, `+` and `-` scale the image size; `r` will rotate the image 90° at a time; and `i` (`shr-browse-image`) will browse to that image directly, from which page you could perhaps download it. With a prefix argument, `i` copies the URL of the image to the Kill Ring.

Likewise, `w` (`eww-copy-page-url`) will copy the URL of the link at Point to the Kill Ring, or, if Point is *not* on a link, the URL of the page you're looking at.

Sometimes, after following a link, you'll find that EWW is not up to handling that web page, typically because it depends heavily on Javascript. The solution for these cases is `&` (`eww-browse-with-external-browser`), which pops up the current page in another web

browser, probably outside of Emacs. But which browser? It uses the Browse URL facility's *secondary browser*, which you've presumably configured (if necessary) to your liking; see below.

Managing "Tabs" (EWW Buffers)

If you invoke `M-x eww` (or `G` in an EWW Buffer) with a prefix argument, i.e. `C-u M-x eww`, your web page will come up in a new Buffer, preserving your other EWW Buffers. You can think of these Buffers as browser "tabs". When you're following a link, `M-RET` (`eww-open-in-new-buffer`) or `C-u C-u RET` will open that link in a new Buffer.

Obviously you can "switch tabs" using any Buffer switching command, but from an EWW buffer you can switch with `s` (`eww-switch-to-buffer`), which has the advantage of offering up (via Completion) *only* your EWW Buffers, and showing their URLs with their Buffer names. `S` (`eww-list-buffers`) brings up a Buffer with a line for each EWW Buffer, showing their page titles as well. Just hit `RET` on the line of the web page you want to switch to. (You can also invoke `M-x eww-list-buffers` from outside of EWW.) This is probably the friendliest way to switch tabs.

Browser History

The left- and right-arrow buttons of the standard web browser are just the two EWW commands `l` (`eww-back-url`) and `r` (`eww-forward-url`): `l` goes *left*—back—to the web page that was previously displayed in the current EWW Buffer, and `r` lets you undo that by going *right*. `H` (`eww-list-histories`) pops up a new Buffer with the history of this Buffer's previous pages: their titles and URLs, just like the `S` command does for "tabs".

Web Site Navigation

EWW has convenience functions for navigating the structure of a web site. When a web site has next-page and previous-page links, whether represented as text or graphical arrows or the like, you can use EWW's `n` (`eww-next-url`) and `p` (`eww-previous-url`) commands to follow those links. The `u` (`eww-up-url`) command likewise follows a page's "up" link and `t` (`eww-top-url`) follows its "home" link. Needless to say, these commands can't be guaranteed to work with every site—they depend on the web site author having clearly labeled those links in the site's HTML metadata.

EWW Bookmarks

You can bookmark the current web page with `b` (`eww-add-bookmark`). This is an EWW-specific bookmark, not a standard Emacs Bookmark, but you can also add the current web page to your Emacs Bookmarks with the usual `C-x r m` (`bookmark-set`), or do both: your choice. The `B` (`eww-list-bookmarks`) command pops up a Buffer of all EWW-specific bookmarks that's similar to the `S` and `H` Buffers. You can also navigate sequentially through your EWW bookmarks with `M-n` (`eww-next-bookmark`) and `M-p` (`eww-previous-bookmark`), which I think is a weird idea: is the sequence of *your* web browser bookmarks significant to you? To me these feel almost like a way of jumping to a random bookmark, but YMMV.

Miscellaneous EWW Commands

EWW supports the common `special-mode` binding of `g` to Revert your Buffer, which in this case means to reload the page, and the usual `q` to quit the window. `w` will copy the URL of the current page to the Kill Ring, but only if Point is not on a link. You can view the HTML source of the current page in an `*eww-source*` Buffer with `v` (`eww-view-source`). There's a very powerful function for Org Mode users: `C-c C-x C-w` (`org-eww-copy-for-org-mode`) will copy the text in the Active Region to the Kill Ring, translating all links to Org syntax.

Finally, the command `C` (`url-cookie-list`) pops up a Buffer displaying all the cookies that Emacs has received in this session; see *HTTP Cookies* for details.

EWW From the Command Line

If you'd like to invoke EWW outside of Emacs from the shell command line, you can use this trivial script (I name it `~/bin/eww`):

```
#!/usr/bin/env sh
CREATE=
case "$1" in
-c) shift; CREATE=-c ;;
--) shift ;;
-*) exit 124 ;;
esac
exec emacsclient $CREATE --eval '(eww-browse-url "'"$*"'" (quote (4)))'
```

Now you can say things like:

```
$ eww https://www.gnu.org/software/emacs/
```

or:

```
$ eww gnu emacs web browsers
```

and it will open EWW in an existing Frame of your running Emacs, assuming you're running the Emacs Server; if you'd prefer it to open a new Frame, add the `-c` option. If you don't run the Server, just change `emacsclient $CREATE` to `emacs --no-desktop` and it'll start up a fresh Emacs for your (this will of course be slower).

Browse URL

URLs can be found anywhere in Emacs. They might be in the text of some file you're editing, or in the documentation of an Emacs command, or in an email. You might be about to type one in. The *Browse URL* subsystem's job is to make it easy for you to browse these URLs. Browse URL also typically handles clickable links that are actually URLs rather than internal Emacs links. It predates EWW and so has extensive support for external web browsers (though it also supports EWW).

The fundamental Browse URL command is, appropriately enough, `M-x browse-url`, which prompts you for a URL, with a default that comes from the text at Point: so if Point is in or next to a URL, that will be the default. You can edit it, or zap it and reenter a URL from scratch, or yank a URL from the Kill Ring, as you like. When you hit `RET`, the URL will be opened in your "preferred web browser". But what *is* your preferred web browser?

With no Customization, Browse URL will try to choose a suitable one for you. Strangely (in my opinion), as of this writing, it will never choose EWW! The default is first guided by your operating system: if you're running Microsoft Windows, it will use the default Windows web browser[379]; if Mac OS, the default Apple browser. If you're running Unix, it will use the browser specified the by the freedesktop.org XDG specification[380], falling back to a list of commonly-installed browsers like `firefox(1)`, `chromium(1)`, KDE, `chrome(1)` and finally `lynx(1)` running in a terminal.

[379] Unless you're using Cygwin, or are running Emacs in WSL.

[380] I.e., whatever `xdg-open(1)` would run.

You should give Browse URL a test-run and see if you like the browser that's chosen for you:

```
M-x browse-url RET https://www.gnu.org/software/emacs/ RET
```

If you're not happy, you should Customize the variable `browse-url-browser-function` and change it.

There's also a notion of your *secondary* web browser choice: various commands make it easy for you to occasionally open a URL in this other web browser—for example, in EWW, by following a link

at Point with `C-u RET`. Setting a secondary browser especially makes sense if you choose EWW as your primary browser. For example, I set my secondary browser to be `firefox(1)`, which I use for web sites that require Javascript. I recommend Customizing `browse-url-secondary-browser-function`.

Now you're ready to use the fleet of Browse URL commands. In addition to plain old `browse-url`, you can use the following:

`M-x browse-url-at-point` browse the URL at Point; like `browse-url`, but doesn't prompt.

`M-x browse-url-of-file` render the current Buffer, presumably of HTML, in your browser.

`M-x browse-url-of-buffer` like `browse-url-of-file`, but works when the Buffer isn't visiting a file, or when the Buffer is narrowed.

`M-x browse-url-of-region` render, in your browser, the HTML in the Region

`M-x browse-url-of-dired-file` in a Dired Buffer, open the file on this line in your browser; this is bound to `W` in `dired-mode`.

Additionally, when looking at a URL, `M-x find-file-at-point` is an entry point to Browse URL; see *Find File at Point*.

You can also explicitly invoke Browse URL to use a specific browser by calling one of the commands in Table 54.

Table 54: Browse URL Browsers

`M-x` Command	Browser
`browse-url-chrome`	`chrome(1)`
`browse-url-chromium`	`chromium(1)`
`browse-url-default-macosx-browser`	Mac OS `open` command
`browse-url-default-windows-browser`	Windows `open` command
`browse-url-elinks`	`elinks(1)` in a terminal
`browse-url-epiphany`	Gnome web browser
`browse-url-firefox`	`firefox(1)`
`browse-url-generic`	your custom browser
`browse-url-kde`	KDE web browser
`browse-url-text-xterm`	text-mode browser in an `xterm(1)`
`browse-url-text-emacs`	text-mode browser in an Emacs terminal
`browse-url-w3`	old all-Elisp browser
`browse-url-xdg-open`	`xdg-open(1)`
`eww-browse-url`	EWW

The `browse-url-text-xterm` command fires up any text-mode web browser, named by `browse-url-text-browser`. The default value is

`lynx`; IMHO better choices are `elinks(1)` (which does a really nice layout) or `w3m(1)` (which does images in the terminal).

The `browse-url-generic` command is what you can use to configure some other exotic web browser (perhaps the Emacs-inspired Nyxt, or Opera). Just set `browse-url-generic-program` to the name of your browser, and optionally set `browse-url-generic-args` as needed. Most of the other browser-specific commands in Table 54 have their own `browse-url-*-args` variable as well, in case you want to add some options.

Browse URL not only handles `http:` (and `https:`) URL schemes, but also the `mailto:` scheme; when presented with a `mailto:` URL it invokes your preferred mailer; see *Mail, News, and Feeds*. You can teach it to handle other URL schemes by Customizing `browse-url-handlers`; this variable is flexible enough for you to define custom handling of specific web sites too, perhaps sending Javascript-dependent shopping domains to your secondary browser automatically.

Goto Address Mode

I mentioned that URLs can appear in almost any Buffer, and the Browse URL commands will let you jump to them. The Minor Mode `goto-address-mode` is a nice enhancement: it colorizes all the URLs (and also email addresses) in your Buffer, making them more noticeable, and when Point is at one of these locations, `C-c RET` (`goto-address-at-point`) invokes `browse-url`.

You can turn it on everywhere by invoking `global-goto-address-mode` in your Init File, but I find that a bit too sweeping; after all, many application Buffers, like EWW and Gnus, have their own inbuilt facility. I turn it on in Shell Modes and, via `goto-address-prog-mode`, in programming language Major Modes, where it's only activated in comments and strings.

Init File

```
;; goto-address-mode is handy in these modes
(dolist (hook '(shell-mode-hook eshell-mode-hook))
  (add-hook hook #'goto-address-mode))
(add-hook 'prog-mode-hook #'goto-address-prog-mode)
```

HTTP Cookies

All Emacs commands that fetch data from a web server use functions from the `url` package, and handling of all HTTP cookies is done in these functions.

While cookies are obviously essential for sites requiring authenti-

cation, managing shopping carts, and the like, since such sites almost always require Javascript, they don't work in EWW. For most other sites, cookies are unnecessary and probably only used to track you. I block all of them and this has never yet interfered with my use of any web site in EWW. You can block them with this Init File snippet:

```
(setq url-cookie-untrusted-urls '(".*")) ; cookies: generally a bad idea
```

If you feel less extreme about this than I do, you can Customize this variable to block only specific domains or URLs instead.

Note that if you don't use EWW and configure Browse URL to invoke an external web browser, then cookies will of course be handled by that browser, and not by Emacs.

User Options

There are many User Options related to web browsing that you might want to Customize. Do `M-x customize-group` for the `eww`, `browse-url`, and `url-cookie` groups.

References

Free Software Foundation. 2020. *EWW.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/eww.html`. Read in Emacs with `M-x info-display-manual RET eww RET`.

The Calendar, Diary, and Clocks

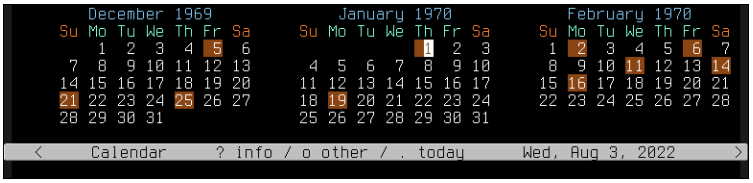

Figure 52: Calendar for the Epoch

The calculation of dates and holidays is extremely complex, and Emacs has a correspondingly powerful Calendar subsystem to handle this. You can pop up a three-month calendar, centered on today, in a compact Window with `M-x calendar`. Add a prefix argument and it will prompt you for a year and month on which to center (instead of today). Figure 52 shows the Calendar window for the Unix Epoch[381], which is 00:00:00 UTC on 1 January 1970. The highlighted dates are holidays.

[381] The official birthday of the Unix operating system.

The Emacs Calendar can display any month since January of the year 1 of the Common Era; the Calendar always displays the Gregorian calendar, even for a date at which the Gregorian calendar did not exist (i.e. before October 1582). However, the Calendar supports eleven additional *calendar systems*—Bahá'í, Chinese, Coptic, Ethiopic, French Revolutionary, Hebrew, Islamic, ISO, Julian, Mayan, and Persian—and can translate between them.

Besides displaying the calendar for any month, the Calendar subsystem can count days between arbitrary dates, display holidays and astronomical information, convert dates to and from the other calendar systems, generate printed calendars (in HTML, PDF, or LaTeX forms), and it also has a powerful Diary to keep track of your appointments. There's also a timeclock facility for tracking your hours, but I think that's better done in Org Mode.

Setting Up the Calendar

You should Customize the two variables `calendar-latitude` and `calendar-longitude` to exploit some of the Calendar's more interest-

ing features; these values are easy to get from a gazetteer[382], map or mapping software, or from Wikipedia in many cases. The easiest way to express these values is as a Lisp vector, as in this example:[383]

[382] Yes, it's a thing!

[383] N.B. we only use degrees and minutes, don't specify seconds.

```
(setq calendar-latitude  [43 02 north]) ; = 43°02'49"N
(setq calendar-longitude [76 08 west])  ; = 76°08'40"W
```

While you're at it, you might set `calendar-location-name` to a string naming your location; this is totally optional and merely makes some displays look a little nicer.

```
(setq calendar-location-name "Syracuse, NY")
```

You can of course set these via `M-x customize-variable` instead.

I also recommend these Init File settings so that you'll get colorized holidays and diary entries by default:

Init File

```
(setq calendar-mark-holidays-flag t       ; colorize holidays in the calendar
      calendar-mark-diary-entries-flag t)  ; also diary entries
```

Motion

Moving around in the Calendar is designed by analogy to the textual object motion commands you're already familiar with, from the smallest units (days = characters) to the largest (years = pages). All these commands take numeric arguments, so it's easy to jump forward six months, say, with `C-u 6 M-}`. See Table 55. You can jump

Table 55: Calendar Motion Commands

Backward	Unit	Forward	Analog
`C-b`, ←	day	`C-f`, →	(character)
`C-p`	week	`C-n`	(line)
`M-{`	month	`M-}`	(paragraph)
`C-x [`	year	`C-x ]`	(page)
Beginning		Ending	
`C-a`	week	`C-e`	(line)
`M-a`	month	`M-e`	(sentence)
`M-<`	year	`M->`	(buffer)

directly to a specific date with the commands in Table 56.

Counting Days

You can count the number of days between any two dates in the Calendar. Just move to one of the days, set the Mark, move to the other day[384], and invoke `M-=` (`calendar-count-days-region`).

[384] Feel free to change the display if your second date isn't visible.

Command	Action
`g d`	go to specific date
`o`	center calendar on specific month
`g D`	go to specific day number in year
`g w`	go to specific week number in year
`.`	go to today
`>`	scroll one month forward
`<`	... backward
`C-v`	scroll three months forward
`M-v`	... backward

Table 56: Specific Calendar Dates and Scrolling

Holidays

Emacs knows a lot of holidays, both secular United States holidays and major religious holidays in the Bahá'í, Chinese, Christian, Islamic, and Jewish traditions.[385] Use `M-x customize-group RET holidays` to choose the ones you're interested in. When you're in the Calendar, you can display them with the commands in Table 57.

[385] The Package Manager has packages defining holidays for an additional 18 countries or religions.

Command	Action
`h`	display Holidays for date at point
`a`	display All holidays in view in another window
`x`	mark holidays in view
`u`	unmark ...

Table 57: Calendar Holiday Commands

My recommended setting for `calendar-mark-holidays-flag` above *marks* (colorizes) the holidays in the Calendar Window by default, so you won't need the `x` command unless you've unmarked them with `u` (for a clearer view perhaps).

`M-x holidays` pops up the same window as the `a` command in the Calendar Window, but you can use it without first opening the Calendar; `M-x list-holidays` prompts you for a range of years and generates a Buffer listing all the known holidays in that time range.

The Emacs Ephemeris: Astronomical Information

The Calendar can compute the times of sunset and sunrise, the phases of the moon[386], and the dates of upcoming eclipses.

[386] Crucial information for any programmer...

Command	Action
`S`	display time of Sunrise and Sunset
`M-x calendar-sunrise-sunset-month`	... for every day this month
`M-x sunrise-sunset`	... for today
`C-u M-x sunrise-sunset`	... for a given date
`C-u C-u M-x sunrise-sunset`	... and a given location
`M`	display Moon phases in calendar view
`M-x lunar-phases`	... the same
`C-u M-x lunar-phases`	... for a given month and year

Table 58: Calendar Astronomical Commands

`M-x lunar-phases` includes upcoming eclipses in its listing; here's an example:

```
Friday, February 2, 2024: Last Quarter Moon 5:23pm (CST)
Friday, February 9, 2024: New Moon 5:01pm (CST)
Friday, February 16, 2024: First Quarter Moon 9:02am (CST)
Saturday, February 24, 2024: Full Moon 6:28am (CST)
Sunday, March 3, 2024: Last Quarter Moon 9:29am (CST)
Sunday, March 10, 2024: New Moon 4:03am (CDT)
Saturday, March 16, 2024: First Quarter Moon 11:12pm (CDT)
Monday, March 25, 2024: Full Moon 1:58am (CDT) ** Lunar Eclipse **
Monday, April 1, 2024: Last Quarter Moon 10:20pm (CDT)
Monday, April 8, 2024: New Moon 1:23pm (CDT) ** Solar Eclipse **
Monday, April 15, 2024: First Quarter Moon 2:14pm (CDT)
Tuesday, April 23, 2024: Full Moon 6:47pm (CDT) ** Lunar Eclipse possible **
```

To and From Other Calendar Systems

On the `g` keymap are commands to *go to* a date expressed in one of the non-Gregorian calendar systems, and on the `p` keymap, to *print* (i.e. display) the current date in another system. Converting to the

Goto	Print	Calendar System
`g a`	`p a`	astronomical (Julian) day number
`g b`	`p b`	Bahá'í
`g C`	`p C`	Chinese
`g k`	`p k`	Coptic
`g e`	`p e`	Ethiopic
`g f`	`p f`	French Revolutionary
`g h`	`p h`	Hebrew
`g i`	`p i`	Islamic
`g c`	`p c`	ISO commercial calendar
`g w`		ISO commercial calendar week
`g j`	`p j`	Julian
`g m...`	`p m`	Mayan
`g p`	`p p`	Persian
	`p o`	various other calendars

Table 59: To and From Other Calendar Systems

Mayan calendar is complex enough to require its own keymap of

seven extra bindings; see "Mayan Calendar" in the *Emacs* manual.

The `p o` command displays the selected date in all the other calendar systems; here's the result for the Epoch:

```
Day 1 of 1970; 364 days remaining in the year
ISO date: Day 4 of week 1 of 1970
Julian date: December 19, 1969
Astronomical (Julian) day number (at noon UTC): 2440588.0
Fixed (RD) date: 719163
Hebrew date (before sunset): Teveth 23, 5730
Persian date: Dey 11, 1348
Islamic date (before sunset): Shawwal 22, 1389
Bahá'í date: Sharaf 2, 126
Chinese date: Cycle 77, year 46 (Ji-You), month 11 (Bing-Zi), day 24 (Xin-Si)
Coptic date: Kiyahk 23, 1686
Ethiopic date: Takhsas 23, 1962
French Revolutionary date: Primidi 11 Nivôse an 178 de la Révolution, jour du Granit
Mayan date: Long count = 12.17.16.7.5; tzolkin = 13 Chicchan; haab = 3 Kankin
```

Printed Calendars

There are a variety of commands to generate "printed" calendars in HTML, LaTeX, and (indirectly via LaTeX), PDF. See the Manual for details.

The Diary

Emacs has a Diary facility that allows you to record appointments, reminders, meetings, birthdays, and the like. They can be marked in the Calendar[387] and the appointments for the day can be displayed in a pop-up Window via `M-x diary`. Diary entries are entered in your diary file, defined by `diary-file`, in a flexible format that allows for complex dates and repeats. Here's an example diary file:

[387] And will be with my recommended setup.

```
4/15 TAX DAY
*/1  Submit Monthly Time Card
%%(diary-anniversary 10 20 1874) Charles Ives' Birthday: %d years old

Wednesday
  2:30pm-3:30pm Staff Meeting
  5:00pm-7:00pm Study Group
```

The easiest way to make Diary entries is from inside the Calendar via the commands in Table 60. See "Format of Diary File" in the *Emacs* manual for a description of the syntax used in manual edits.

It must be said that for many Emacs users, myself included, the Org Mode Agenda has largely replaced the functionality of the Diary. The Agenda can incorporate the Diary, so anything you record

Command	Action
`d`	Display Diary entries for this date
`M-x diary`	... the same
`s`	Show the diary file
`m`	Mark all dates with diary entries
`u`	Unmark all calendar marks
`i d`	Insert a diary entry for this Date
`i w`	... for this day of the Week (e.g. any Thursday)
`i m`	... for this day of the Month (e.g. any 12th)
`i y`	... for this day of the Year

Table 60: Calendar Diary Commands

with the Diary will show up if you display the Agenda; this Init File snippet does the job:

Init File

```
(setq org-agenda-include-diary t)  ; incorporate the diary into the agenda
```

If you use the Agenda and don't already use the Diary, the main reason to use it occasionally is because the Diary's ability to express complex recurring dates exceeds Org's.

Appointments

Emacs can notify you of any Diary entries with an attached time of day through the Appointments subsystem.[388] A certain amount of time before the appointment occurs, a notification will pop up in a new window, and the bell will ring. More notifications will pop up until the appointment time has passed. You can customize the details via `M-x customize-group RET appt`, but this Init File snippet will enable the defaults:

[388] The Org Agenda uses the same notification system.

Init File

```
(appt-activate +1)        ; appointment notifications, please
(require 'notifications)  ; also via desktop notifications
```

On most operating systems, this snippet will also generate OS notifications.[389]

[389] Unix users should make sure D-Bus is enabled.

You can add a nonce appointment as a sort of alarm without going to the trouble of creating a Diary or Agenda appointment with `M-x appt-add`; it will prompt you for the time, a description, and the number of minutes of lead time. Any upcoming appointment notifications for the day can be canceled with `M-x appt-delete`; you get to confirm the deletions one at a time, so if you just answer "no" to all of them, this is also usable as a way of checking which appointments are coming up. Note that these nonce appointments don't persist across Emacs sessions!

Customization

The Calendar is highly customizable; `M-x customize-group RET calendar` offers you the option to change how everything is displayed, marked, and named, and much more.

Holidays are of particular note. The default holidays are those common throughout the United States, and only a small set of the (many) religious holidays known to Emacs are included. `M-x customize-group RET holidays` makes it easy to include or exclude any of these.

You can readily add your own holidays, perhaps local holidays, holidays for your workplace or university, birthdays of your friends or favorite celebrities. I think it's easiest to do this in your Diary; second easiest is in your Init File.

The Calendar is capable of computing even the most complicated of holiday dates (like Passover and Easter), and you can use its powerful functions for your own dates. Here, for example, is an entry for the date of the US Presidential Election:

```
(add-to-list 'calendar-holidays
             '(holiday-sexp
               '(when (zerop (% year 4))
                  (calendar-gregorian-from-absolute
                   (1+ (calendar-dayname-on-or-before
                        1 (+ 6 (calendar-absolute-from-gregorian
                                (list 11 1 year)))))))
               "US Presidential Election"))
```

Clocks and Time

In addition to calendar features, Emacs has a variety of clocks for displaying the current time.

Mode Line Clock

You can display the current time in the Mode Line; see *Optional Mode Line Features*.

World Clock

`M-x world-clock` pops up a `*wclock*` Buffer displaying the current time in various world time zones:

```
Seattle   Friday 05 August 12:14 PDT
New York  Friday 05 August 15:14 EDT
London    Friday 05 August 20:14 BST
Paris     Friday 05 August 21:14 CEST
```

```
Bangalore Saturday 06 August 00:44 IST
Tokyo     Saturday 06 August 04:14 JST
```

The times in this Buffer update continuously as long as the Buffer is displayed in a Window. You can `M-x customize-variable RET world-clock-list` to choose your own preferred time zones.

Time Stamps in Files

You can have Emacs update a time-stamp line every time you save a file. If you enable this feature, then when you save this file:

```
Meeting Notes
Time-stamp:

* Boring Topic
  Blah blah...
```

the `Time-stamp:` line will be updated to today's date:

```
Time-stamp: 2022-10-13 17:25:09
```

If you edit and save the file again, the time-stamp will be updated. The magic string "Time-stamp:" and the format of the time and date are of course customizable. The facility can be enabled on a file-by-file basis.

It used to be common for programmers to have time-stamps in all their source files, but in my opinion, this feature is pretty annoying now that we keep all our files under version control, and I no longer use it. After all, your VCS knows exactly when you last modified each file, and a `C-x v l` (`vc-print-log`) will show you the time-stamp. Also, most typesetters will allow you to readily include the publication date in formatted versions of your documents.

But, if you think this feature sounds useful, see "Time Stamps" in the *Emacs* manual.

Timeclocks

Emacs also has several facilities for clocking your work hours and recording how much time you spend on some task or project. Just invoke `M-x timeclock-in` when you start work—it'll prompt you for a project name—and when you're done, `M-x timeclock-out`, or `M-x timeclock-change` to switch to working on a different project.

The timeclock log is stored in the file named in `timeclock-file` in s simple format:

```
i 2022/10/13 17:38:27 test1
o 2022/10/13 17:39:31
```

```
i 2022/10/13 17:39:33 test2
o 2022/10/13 17:41:21 done
```

If you're a programmer, you can whip up code to process that data easily enough, but Org Mode has a much more powerful timeclock facility that's integrated with your Org Agenda and includes report generation, effort estimates, and data export to CSV for incorporation into external applications.

> I keep sticking to Emacs because it has one huge ace up its sleeve that other editors simply cannot match. Emacs has a package that helps me organize my workflow, focus my note-taking and even keep a timeclock for how long I spend working on tasks. This package is called Org mode. — Christine Dodrill

References

Reingold, Edward M. and Nachum Dershowitz. 2018. *Calendrical Calculations: The Ultimate Edition.* Cambridge, UK: Cambridge University Press..

Hinman, Lee. 2017. *Clocking Time with Org-mode.* `https://writequit.org/denver-emacs/presentations/2017-04-11-time-clocking-with-org.html`.

Version Control

Version control is an essential component of software engineering and, I would say, of any sort of authoring, from articles and essays to novels and oversized books about Emacs. I'll assume you're already using version control; if not, I strongly encourage you to check out the Wikipedia article and get started.

Version control systems (VCS) are nowadays almost synonymous with Git, but there are in fact many other VCS's to choose from. I prefer Mercurial (Hg) myself, and I also still use the ancient RCS in certain cases. But I have to use other VCS's occasionally (Git especially), when I'm working with other people's code.

Though there are two broad categories of VCS's—the modern *merge-based* style, and the older *lock-based*—most VCS's have analogous features. But wildly different user interfaces: keeping several of them straight is a daunting task.

Emacs to the rescue! The Emacs version control interface, VC, tries valiantly (and quite successfully) to provide a common abstraction over these varying systems so that, regardless of the system in use for a given file or directory, you can use the same commands to perform the most common operations. Most of the frequently used commands work appropriately across all supported VCS's, but some of them aren't consistently supported yet: you may need to occasionally pitch in with the underlying commands via `M-!` (`shell-command`) or `M-x shell`.

There are some slight differences in the way VC commands work with older lock-based systems like RCS; since few people use such VCS's these days, I'll describe only merge-based systems in detail. As always, the Manual has the complete story.

From here on, *VC* refers to Emacs's VC commands, and *VCS* to the underlying version control system being used in any given case.

Supported Version Control Systems

Out of the box, Emacs VC supports nine version control systems; see Table 61. Other systems (for example, Darcs and Fossil) have support

in the Package Manager.

Table 61: Supported Version Control Systems

Abbreviation	Version Control System
`RCS`	GNU RCS
`CVS`	Concurrent Versions System
`SVN`	Apache Subversion
`SCCS`	Source Code Control System
`SRC`	SRC[390]
`Bzr`	GNU Bazaar
`Git`	Git
`Hg`	Mercurial
`Mtn`	Monotone

[390] I've never heard of this one! Apparently a front-end to RCS?

(Of course, you need to install the VCS's themselves (any that you want to use) outside of Emacs via your operating system's package manager.)

It must be mentioned that one of the modern *killer apps* for Emacs is Magit, a bespoke version control package for Git (only). People are fanatical about it, and while I prefer the simpler VC abstraction for the limited amount of work I need to do with Git, I'd be remiss not to mention it. Just install it from the Package Manager as usual. But from here on out, I'll be discussing VC only, and everything will apply equally to any of the above VCS's.

VC "Modes"

VC provides two main modes of interacting with the underlying VCS, which I'll call File Mode[391] and Project Mode. File Mode applies when you issue VC commands from a file-visiting Buffer, but *also* when you're in a Dired Buffer (where it applies to the file at Point). Project Mode applies when you're in the special `vc-dir-mode` Buffer created by `C-x v d` (`vc-dir`), which is for interacting with the whole repo at once. We'll consider these two modes of working separately.

[391] Neither an Emacs Major Mode nor Minor Mode here...

VC File Mode in One Command

The most frequent VCS actions are cleverly subsumed under one state-smart command, `C-x v v` (`vc-next-action`). You can spend much of the day issuing that one command repeatedly, and only occasionally delving into the other VC commands.

`C-x v v` performs the appropriate next action on the file visited in the current Buffer (or, if you're in a Dired Buffer, the file at Point). The action depends on the version control state of the file in this order:

File State	`C-x v v` Action
No Repository!	Initialize the repo
Unregistered	Register the file
Unmodified	No action
Modified	Commit changes

So suppose you're working on a project in an existing VCS repository, and you create a new file with `C-x C-f` (`find-file`) as usual. After typing in some content, you hit `C-x v v`; since the file is new, it gets *registered* with the repo—corresponding to the *add* command of most systems.

After some more editing, you issue another `C-x v v`—this time, VC *commits* your changes (corresponding to the *commit* or *check-in* command). This pops up two new Buffers in two new Windows: `*log-edit-files*`, which displays the names of the files being committed (in the File Mode case, only one filename: that of the file you're editing) and `*vc-log*`. The latter will be the selected Window, and you're expected to type in a commit message or summary of your changes[392].

[392] Emacs allows this message to be empty, if your VCS (and boss) doesn't object.

Typically the first line of the commit message is a short pithy summary, and you can use any number of lines following it to describe your changes in as much detail as you like. When you're done, just type the usual `C-c C-c` (`log-edit-done`) and your changes are safely committed to the repo; both of the Windows will vanish. If you've changed your mind, you can abort the commit with `C-c C-k` (`log-edit-kill-buffer`), which will also clean up the Windows.

That's it! I can work for much of the day with just this one command.

More VC File Mode Commands

If the only thing you ever did with your VCS is add and commit files, you could dispense with the VCS entirely! The whole point is that you occasionally need to use other features of version control, primarily to save your butt when you screw up. The major categories of butt-saving include:

- comparing the current state of your file to a previous state (a.k.a. *diffing*)
- blaming somebody else for problems in your file[393]
- reverting that person's changes so you can fix them
- getting an idea of the *history* of changes to the file (viewing the log)

[393] My personal favorite...

- restoring a previous version of your file
- tagging revisions
- pushing and pulling from remote repos
- and the most complex, most annoying, and probably most important thing: working with branches

Table 62: VC File Mode Commands

Key	Category	Action
`C-x v v`		jack of all trades: DWIM
`C-x v i`	Init	Initialize a repo or add a file
`C-x v =`	Diff	show diff of this file
`M-x vc-ediff`		... in Ediff
`C-x v D`		... of all files in the project Directory
`C-x v h`		... of just this region Here
`C-x v l`	Log	show change Log of this file
`C-x v L`		... of all files in the project
`M-x vc-log-search`		search the text of log entries
`C-x v a`		update the `ChangeLog` file
`C-x v ~`	View	show an older version in another buffer
`C-x v g`		assign blame for each line (annotate)
`C-x v u`	Revert	Undo changes to this file
`C-x v x`	File	delete (X-out) this file via the VCS
`M-x vc-rename-file`		rename a file
`C-x v G`		ignore this file Glob
`C-x v I`	Remote	describe (log) Incoming changes
`C-x v +`		... pull (add) them in
`C-x v O`		describe (log) Outgoing changes
`C-x v P`		.... Push them out
`C-x v r`	Branch	checkout (Retrieve) a given branch
`C-x v s`		tag this file
`C-u C-x v s`		make current changeset a new branch
`C-x v m`		merge in a given branch
`C-x v M D`		show a diff of the common ancestor
`C-x v M L`		show the log of the common ancestor

Initializing a Repository

When you're beginning an entire new project, you need to choose which VCS you're going to use and create a new repository. The first step is to create a new project directory. Just create your first project file in a non-existent directory with `C-x C-f /new/directory/new-file`; as usual, Emacs will open a Buffer visiting `new-file` and ask if it

should create the directory `/new/directory`—say yes, of course. Now register the file with a simple `C-x v v` (or if you're feeling deliberate, `C-x v i` (`vc-register`), which exists solely to register new files and repos). Emacs will respond in the Minibuffer with:

```
/new/directory/new-file is not in a version controlled directory.
Use VC backend:
```

and will offer all the supported backends for Completion: Bzr, Git, Hg, RCS, SCCS, SRC, and SVN. Choose the one you want and you now have a new repo.

Diffing and Comparing

It's easy to compare the current file to the most recent checked-in version: just do `C-x v =` and you'll get a colorized `diff-mode` Buffer; see *Diffing and Merging* for details. `C-x v D` pops up a multi-file Buffer with all the modified files in the project. You can also diff the Region with `C-x v h` to avoid getting overwhelmed with detail.

The `diff-mode` Buffer features some 28-odd useful commands, but if you want something fancier, `M-x vc-ediff` shows the comparison via the super-powerful Ediff subsystem. I rarely do this[394]; `diff-mode` itself is pretty powerful. Among the more useful commands are `C-c C-c` to jump from the diff hunk at Point to its location in the file (visiting the file as needed), and you can revert individual hunks in the file one-by-one; this is just a `diff-mode` feature, so see *Simple Diffing* for details.

[394] Though I use Ediff daily in other contexts.

All of these commands compare the saved files in the working directory with the most recent checked-in versions. With a Prefix Arg, you can specify any previous version, identified however your VCS does it (revision numbers, hexadecimal idents, tag names). This can be more convenient to do from a VC log Buffer.

Examining the Logs

Analogously to VC diffing, `C-x v l` shows the VCS log for the current file, and `C-x v L` does the same for all the files in the project (the changesets). There are many handy commands to navigate and manipulate the log Buffer; be sure to do `C-h m` (`describe-mode`). The one I use the most is `=`, which generates a diff against the revision at Point.

`M-x vc-log-search` will search the text of log entries; this command is not supported by all VCS's.

Viewing Older Revisions

From a log Buffer you can pop up the complete text of the older version at Point with `f` (`log-view-find-revision`). The text is popped up in a new Buffer with a name in the form `FILENAME~VERSION~`.

Outside of the log Buffer, you can pop up a `FILENAME~VERSION~` buffer with `C-x v ~` (hence the mnemonic behind the key binding[395]), which prompts for a version number, ident, or tag.

[395] Admittedly, many of the `C-x v` bindings are not very mnemonic...

`C-x v g` annotates the file (or as I like to think of it, assigns blame). It pops up a buffer that shows, for each line of the file, who last changed it, the revision id, and the date when it was changed. Each line is colored via a heat-map palette, with blue lines being the oldest and red the youngest. From any given line you can get a complete diff or jump to the location in the file; see Figure 53.

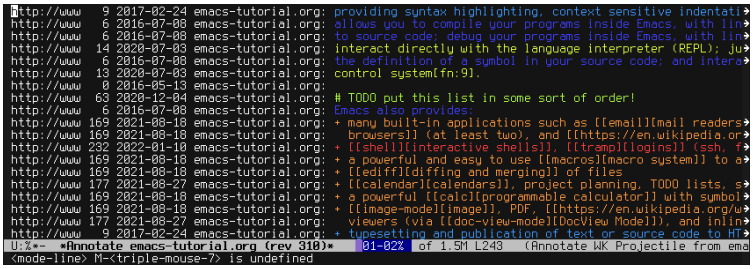

Figure 53: Assigning Blame

Discarding Changes

If you decide that all the changes you've made to your file, through whatever number of saves, were a bad idea, you can revert the file to the most recent checked-in version with `C-x v u`. This is different from `M-x revert-buffer`, which only reverts to the last saved version of the file. `C-x v u` actually replaces the file on disk with the checked-in version, and *then* reverts the Buffer from it.

Other File Operations

In addition to registering a new file, you can remove a file from version control with `C-x v x`; this removes the file from the working directory and informs the VCS of the fact that it's no longer part of this changeset. Of course your VCS will allow you to recover older versions of the file at any time in the future.

It's also important to be able to tell the VCS to ignore certain files and not consider them as part of the repo; this is typically done for build artifacts, backup files, and the like (otherwise, your VCS will constantly be suggesting that you check these files in). Unlike most

of the other commands, `C-x v G` doesn't operate on the current file, but rather always prompts you for a filename or glob pattern, and informs the VCS to ignore it from now on. A Prefix argument prompts for and removes a previously ignored pattern.

Tagging

You can tag the current checked-in version of your project with `C-x v s`. To *tag* means to give a symbolic name to a changeset. You'll be prompted for the name. This command can also be used to create a new branch, as described next.

Branching and Merging

Modern VCS's use *branches* to manage multiple independent lines of development (your project might have a production branch, a development branch, and a bugfix branch, say). *Retrieving* a branch means replacing the files in your working directory with those of a different branch. You do this with `C-x v r`, which prompts you for a branch label (what this is depends on your VCS; it can typically be a version number or identifier, or a symbolic name).

You can't retrieve any branches unless you've made some. You can do this with `C-u C-x v s`, which will make the current changeset a new branch of development. If you want to branch off from an earlier changeset, first switch to that changeset with `C-x v r`

Eventually, two branches will need to be *merged* together (say, to apply the code from a tested bugfix branch into the production branch). Merging is the most complicated task a VCS can do, and VC's `C-x v m` command just initiates the process; you'll have to handle overlap conflicts and the like manually, undoubtedly with the help of the other VC commands we've discussed and the various Emacs Diff commands. This includes `C-x v M D`, which shows a diff of the common ancestor of the two branches being merged, and `C-x v M L`, which shows the ancestor's log.

Working With Remote Repositories

Modern distributed VCS's (DVCS's) have the potential to work with *remote* repos, which may merely be in a different location in the file system but may also be on a different host entirely. You can check whether or not there are remote changes to pull with `C-x v I`; if there are, a log Buffer pops up displaying them. `C-x v O` pops up a log of any outgoing changes.

If there are outgoing changes reported by `C-x v O`, `C-x v P` will push them to the remote, and if `C-x v I` reports incoming changes, `C-x v +` will pull them.[396]

[396] You're not required to do the log command before doing a push or pull.

But where is the remote? Most DVCS's record the current target for pushes and pulls, and this is what will be used. If a remote is not recorded, VC will prompt you for the command to use. A Prefix arg will always prompt for the command.

VC Project Mode

Most of the VC File Mode commands we've discussed apply to the file visited in the current Buffer (or to the file at Point in a Dired Buffer). But sometimes you want to perform VC actions on several or all of the files in your repository at once. This is the job of `C-x v d` (`vc-dir`).

This command pops up a special `*vc-dir*` Buffer for the directory you specify. By default, this is the Buffer's `default-directory`. Depending on your VCS, you may want to always work at the root directory of your project; you can use `C-x p v` (`project-vc-dir`) instead to make sure you always invoke `vc-dir` in the root directory of your project.

When popped up, the `*vc-dir*` Buffer lists all the interesting files in the repo—it's like the `status` command of your VCS—that is, modified files, unknown files (which you probably want to either add to the repo or ignore), and those with a recently changed status. In particular, files that are up-to-date aren't listed.

The Buffer has a header at the top that summarizes the state of the repo, and then lists the files in a two-column form that might look like this:

```
VC backend : Hg
Working dir: ~/txt/emacs-tutorial/
Parent     : 312:caa775acf936 tip
           :  VC: older revs, remotes
Branch     : default
Commit     : 2 modified, 2 unknown
Update     : (current)
Phases     : 5 draft

                         ./
    edited               TODO
    unregistered         cute-cat.jpg
    edited               emacs-tutorial.org
    unregistered         images/vc-blame.png
```

The first column shows the VC status and the second, the file name. You can see that I've modified ("edited") two files, and have two

unknown ("unregistered") files. `cute-cat.jpg` is probably an image file I accidentally saved to this directory; I'll want to eventually move it elsewhere with Dired, or I could delete it from here with the `d` command[397]. `images/vc-blame.png`, however, is a new file that I want to add to this repo.

[397] But who wants to delete a cute cat picture?

`vc-dir-mode` has all the key bindings from Special Mode, a number of commands for marking files, and a bunch of shorter keystrokes that are equivalent to the `C-x v` File Mode commands. You can use the `C-x v` File Mode key bindings if you're more used to them. Table 63 lists the key commands (and their File Mode equivalents)[398]. Typically you *mark* multiple files (like you do in Dired for example) to form a *fileset*, and then use a command to operate on the entire set. Most of the commands apply to the entire marked fileset, to the file at Point if no files are marked, or to all the files in the Region if it is Active.

[398] There are more that I haven't listed; use `C-h m`.

As you'd expect, the mark command is `m` and the unmark command is `u`; marking a directory line (including `./`) is equivalent to marking all the displayed files in that directory. `M` marks all the files with the same status, and `U` unmarks them; with a Prefix arg, these two commands apply to all displayed files.

VC Grepping

You can Isearch and Query Replace from the `*vc-dir*` with the search and replace commands in Table 63, but you can also invoke the Grep facility of your VCS. VC provides a command for Git (`M-x vc-git-grep`), but other VCS's don't have this yet. For Mercurial, I just do:

```
M-x grep RET hg grep -n REGEXP
```

All the `grep-mode` commands work, including Writable Grep. You can probably do something similar for another VCS.

Table 63: VC Dir Commands

Key	A.K.A	Category	Action
`m`		Marks	Mark this file (or all in active region)
`M`			Mark all files with this status
`u`			Unmark this file (or in active region)
`U`			Unmark all files with this status
`v`	C-x v v	Next	jack of all trades: DWIM
`RET`, `e`, `f`		Visit	Find file(s) at point
`o`			... in Other window
`S`		Search	Searches this file(s)
`M-s a C-s`			... isearch across them
`M-s a C-M-s`			... with a regexp
`Q`		Replace	Query replace this file(s)
`i`	`C-x v i`	Init	add a file(s) to repo
`=`	`C-x v =`	Diff	show diff of this file(s)
`D`	`C-x v D`		... of all files
`l`	`C-x v l`	Log	show change Log of this file(s)
`L`	`C-x v L`		... of all files
`G`		Ignore	ignore this file(s)
`d`	`C-x v x`	Delete	Delete this file
`I`	`C-x v I`	Remote	describe (log) Incoming changes
`+`	`C-x v +`		... pull them in
`O`	`C-x v O`		describe (log) Outgoing changes
`P`	`C-x v P`		... push them out
`B s`	`C-x v r`	Branch	checkout (Retrieve) a given branch
`B c`	`C-x v s`		tag this file(s)
`C-u B c`	`C-u C-x v s`		make Current changeset a new branch
`B l`			show Log for this branch
`x`			hide up-to-date and ignored files
`C-c C-c`			kill the running VCS command

Diffing and Merging

If you're a programmer or system administrator, you probably spend a lot of time comparing files, or as we call it, *diffing*. Even non-programmers would benefit from diffing, since anyone who creates and edits files ought to be using *version control*, and version control implies diffing.

The basic Unix tool for diffing is `diff(1)` and its variants; the GNU implementations are the standard.

Diffing is very simple: you run `diff(1)` on two files and eyeball the output. Emacs improves on this by providing excellent syntax highlighting and colorization. But diffing very often implies the need to *merge* the differences to create a new, combined, file, and merging is *work*. Emacs, in my opinion, has the best merge tool: the Ediff subsystem. I probably do at least one merge every day—sometimes several—and when I'm occasionally forced to use some other merge tool[399] I just want to crawl into a hole.

[399] Usually the hated `vimdiff(1)`...

Simple Diffing

The simple Emacs front-end to `diff(1)` is `M-x diff`: it prompts for two filenames, the *new* file and the *old*[400], and runs `diff(1)` on them. It pops up a Buffer named `*Diff*` with nicely colorized output.

[400] If you don't know which file is newer, it doesn't matter which you name first.

There are three other main entry points to the Diff subsystem.

In a file-visiting Buffer, `M-x diff-backup` diffs the file with its backup file—this is way of answering the question, "what changes have I made since the last time I saved it?"—while `M-x diff-buffer-with-file` diffs the (possibly as yet unsaved) Buffer with its file on disk (I only discovered this command recently and it's very handy). Finally, `M-x diff-buffers` generates a diff of two Buffers, even if they aren't visiting files; this saves you from writing Buffers out to temporary files, having to invent two file names and remember to clean them up afterwards.

Additionally, you can conveniently do a diff from Dired with `=` (`dired-diff`), and from VC with `C-x v =` (`vc-diff`) and `C-x v D` (`vc-root-diff`); various other Modes and Packages make it easy to

jump into Diff as well.

Diff Mode

Let's consider a file containing the text of Bertolt Brecht's *Der Pflaumenbaum*:

> Der Pflaumenbaum
>
> Im Hofe steht ein Pflaumenbaum,
> Der ist so klein, man glaubt es kaum.
> Er hat ein Gitter drum,
> So tritt ihn keiner um.
> Der Kleine kann nicht größer wer'n,
> Ja - größer wer'n, das möcht' er gern!
> 's ist keine Red davon:
> Er hat zu wenig Sonn'.
>
> Dem Pflaumenbaum, man glaubt ihm kaum,
> Weil er nie eine Pflaume hat.
> Doch er ist ein Pflaumenbaum:
> Man kennt es an dem Blatt.
>
> – Bertolt Brecht

I copied the file and changed the text according to (my understanding of) the German orthography reform of 1996, and then I ran `M-x diff` on the two files; Figure 54 is the result.

Figure 54: *Der Pflaumenbaum* Diff

Simple Diff Buffers are in `diff-mode`, which does *a lot* more than just colorful highlighting. First let's consider what a diff—also called a *patch*— looks like.

A patch consists of a diff each for one or more pairs of files. Each file pair (here "file" for short) has a *file header* which is followed by the diff, which consists of a set of *hunks*.

In Figure 54 the file header is this part:

```
diff -u /home/keith/txt/emacs-tutorial/brecht1 /home/keith/txt/emacs-tutorial/brecht2
--- /home/keith/txt/emacs-tutorial/brecht1 2022-07-05 18:43:44.497204554 -0500
+++ /home/keith/txt/emacs-tutorial/brecht2 2022-07-05 18:43:44.497204554 -0500
```

File `brecht2` is the newer of the two files. The header shows the exact `diff(1)` command used and the files' modification dates. The `---` and `+++` characters relate the files to the lines of the *hunks*.

A *hunk* is a group of consecutive lines that differ between the pair of files; the hunk always comes in the midst of a number of preceding and following lines that the files have in common; these common lines provide useful context.[401]

[401] Technically, this is the *Unidiff* format generated by running `diff(1)` with the `-u`; in my opinion, this is by far the best format.

In Figure 54 there's only one hunk, which starts with:

```
@@ -4,8 +4,8 @@
```

This means that the hunk consists of 8 lines starting at line 4 of the old file (hence the `-`, as in the file header), and 8 lines starting at line 4 of the new file (the `+`).

In the hunk, lines beginning with `-` are only present in the *old* file, and lines beginning with `+` are only present in the *new* file. Lines beginning with spaces are lines of context common to both files.

From the Diff Buffer, you can actually act on the hunks—undo them in the new file one hunk at a time or apply them backwards to the old file. But most of these actions are easier to do via the very powerful Ediff subsystem.

Ediff

The biggest difference between the Ediff subsystem and the simple Diff commands is that, instead of using a single Diff Buffer containing a patch as its interface, Ediff presents multiple Buffers side-by-side, each containing a colorized version of the old file or the new file. Figure 55 shows the result of invoking `M-x ediff RET brecht1 RET brecht2`.

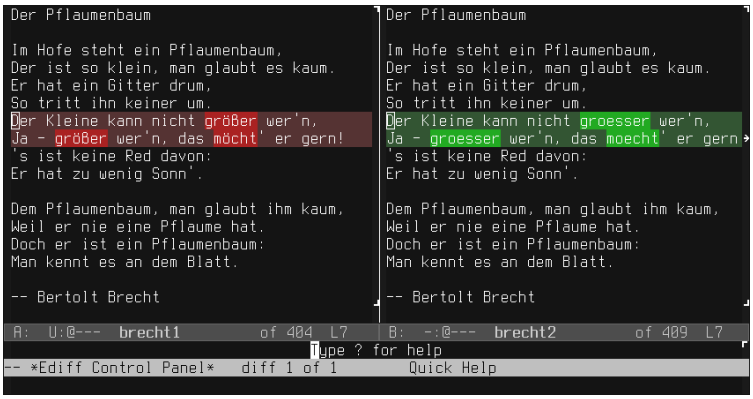

Figure 55: *Der Pflaumenbaum* Ediff

Ediff is much more intuitive. There's no need to interpret the syntax of the output of `diff(1)`: the left window shows the file `brecht1`

and the right, `brecht2`, nicely colorized. The reddish colors show the old hunks, and the greenish the new.

There's also a third window in this Frame, displaying a 1-line `*Ediff Control Panel*` Buffer. When you start up Ediff, this will be the selected Window; the Buffer is in `ediff-mode` and is typically where you issue commands to operate on the two file Buffers. If you type `?` in this Buffer, it will expand to show an explanatory menu of Ediff commands that are valid in this Buffer (only). Each file Buffer will be in the Major Mode appropriate to the file and you can in fact switch to either of the Buffers and edit them.

When Ediffing two files it's very common to want to copy bits of one file to the other. Suppose you've got the same file on two different machines; you may have made changes to both the remote file and the local copy, but not exactly the same changes: you've let the two files get out of sync! Ediff makes it easy, with a keystroke, to copy one diff from file A to file B, another from B to A, and you can jump between the two file Buffers and make any editing tweaks you like. This is a simple way of merging two files.

Personal Preferences

I should mention that Figure 55 isn't what you'll see out of the box if you invoke `M-x ediff`. By default, the Control Panel will open in its own dedicated Frame. I absolutely hate this, and it's frankly unusable with a tiling window manager like mine, so I configure it to open all Ediff windows in the current Frame.

Also by default, the two file Windows are shown one above the other; I much prefer them side-by-side as in Figure 55: as you move from diff to diff, Ediff keeps them neatly aligned and it's easier to visually compare them.

This Init File snippet imposes my preferences on you:

Init File

```
;; don't use a separate Frame for the control panel
(setq ediff-window-setup-function 'ediff-setup-windows-plain)
;; horizontal split is more readable
(setq ediff-split-window-function 'split-window-horizontally)
```

Ediff also radically changes your current Window Configuration; when I quit Ediff, I like to restore my windows to what they were before, with this code snippet:

Init File

```
;; restore window config upon quitting ediff
(defvar ue-ediff-window-config nil "Window config before ediffing.")
(add-hook 'ediff-before-setup-hook
          (lambda ()
            (setq ue-ediff-window-config (current-window-configuration))))
```

```
(dolist (hook '(ediff-suspend-hook ediff-quit-hook))
  (add-hook hook
            (lambda ()
              (set-window-configuration ue-ediff-window-config))))
```

Finally, Ediff will often newly visit one or two files for the purpose of diffing, which clutters up your Emacs. I enable the Ediff Janitor, which will offer to cleanup these files' Buffers for you when you quit.

```
;; offer to clean up files from ediff sessions
(add-hook 'ediff-cleanup-hook (lambda () (ediff-janitor t nil)))
```

Ediff Entry Points

Ediff has a dozen useful entry points, listed in Table 64.

Table 64: Ediff Entry Points

Files	`M-x ediff-files`	diff two files
	`M-x ediff`	... the same
	`M-x ediff-files3`	diff three files
	`M-x ediff3`	... the same
	`M-x ediff-backup`	diff this file with its backup file
	`M-x ediff-current-file`	diff this buffer with its file on disk
Buffers	`M-x ediff-buffers`	diff two Buffers
	`M-x ediff-buffers3`	diff three Buffers
	`M-x ediff-regions-linewise`	diff two Regions in 1 or 2 Buffers
	`M-x ediff-regions-wordwise`	... but word-by-word
	`M-x ediff-revision`	diff this Buffer with an older revision
Windows	`M-x ediff-windows-linewise`	diff two Windows line-by-line
	`M-x ediff-windows-wordwise`	... word-by-word

You can diff files, Buffers, Windows, distinct Regions of Buffers and Windows, and directories (see below); you can also diff files and Buffers in terms of their Version Control revisions. Ediff can compare two files, or three. The common use case for a three-file comparison is when two files share a common ancestor. This occurs frequently when you have a new branch of a project under version control—say, a bugfix branch—and you need to compare the file where you're fixing the bug with the original buggy version: both files will have a common ancestor in their parent revision, and adding this ancestor to the comparison allows Ediff to make very accurate guesses and predictions when you're merging.

Ediff can compare the contents of Buffers, whether the Buffers are visiting files or not, and it can even compare two Regions, whether in the same Buffer or not. Doing this sort of thing in the shell usually requires creating (and cleaning up) temporary files; Ediff takes care of that for you.

Ediff can also compare Windows; this is sort of a shortcut for comparing Regions of Buffers, and it's also an easy way of comparing two parts of the same Buffer: just split the Buffer into two Windows, and line up the parts you want to compare at the tops of the two Windows. When comparing Windows, you can compare *wordwise* (which is nice and detailed) or *linewise* (which is more like a normal diff).

Finally, Ediff can compare entire directories, and has powerful bookkeeping features to help you keep track of where you are in the comparison; see below.

The Expanded `*Ediff Control Panel*`

```
    Move around      |      Toggle features      |        Manipulate
=====================|===========================|============================
p,DEL -previous diff |     | -vert/horiz split   |a/b -copy A/B's region to B/A
n,SPC -next diff     |     h -highlighting       | rx -restore buf X's old diff
    j -jump to diff  |     @ -auto-refinement    |  * -refine current region
   gx -goto X's point|    ## -ignore whitespace  |  ! -update diff regions
  C-l -recenter      |    #c -ignore case        |
  v/V -scroll up/dn  | #f/#h -focus/hide regions | wx -save buf X
  </> -scroll lt/rt  |     X -read-only in buf X | wd -save diff output
    ~ -swap variants |     m -wide display       |
=====================|===========================|============================
    R -show registry |     = -compare regions    |  M   -show session group
    D -diff output   |     E -browse Ediff manual|  G   -send bug report
    i -status info   |     ? -help off           |  z/q -suspend/quit
--------------------------------------------------------------------------------
For help on a specific command:  Click Button 2 over it; or
                                 Put the cursor over it and type RET.
```

Whatever your Ediff entry point, everything is controlled from the `*Ediff Control Panel*`. Do as the one-line Panel Window suggests and hit `?` to expand it. Wherever the Panel refers to "X", it means for you to type the letter `A`, `B`, or `C` to specify one of the Buffers being compared.

Most of the "Move around" commands are obvious: you step back and forth through the files, diff by diff, or jump to a diff by its number (shown in the Control Panel's Mode Line. You can scroll the file Windows pairwise, or bring the current diff back to the center. The `~` (`ediff-swap-buffers`) command swaps the two files in the two Windows, so you can have the old file on the left (where I expect it) or on the right.

The commands in the "Toggle features" section change the appearance of the files or of the Windows. The `|` (`ediff-toggle-split`)

command toggles the Windows between side-by-side (the default with my Init File) or one-over-the-other, and `m` (`ediff-toggle-wide-display`) full-screens the Ediff Frame. `h` (`ediff-toggle-hilit`) and `@` (`ediff-toggle-autorefine`) cycle through a variety of different ways to display the highlighting and refinement of the different words in the diffs. `# #` (`ediff-toggle-skip-similar`) and `# c` (`ediff-toggle-ignore-case`) toggle between ignoring whitespace or case differences. The `# f` (`ediff-toggle-regexp-match`) lets you *focus* on only the diffs that match a Regular Expression (temporarily hiding the diffs that don't), and `# h` is the inverse. The letters `A`, `B`, and `C` toggle the read-only status of the corresponding file Buffers.

The "Manipulate" section has the crucial commands for choosing and copying individual diffs. Lowercase `a` and `b` copy the current diff to the other file. So in Figure 55 typing `a` would cause file A's diff number 1—with the umlauts—to replace file B's orthographic reform version. Upon changing your mind, you could then restore file B's diff with the command `r b`. Conversely, typing `b` would replace file A's umlauts with B's umlaut-free version.

At any point, you can edit either file A or file B, so after copying a diff from the other file, you can tweak it. Invoking `*` (`ediff-make-or-kill-fine-diffs`) (from the Control Panel Buffer) will recompute the refinement colors of the current diff after an edit, if necessary, and `!` (`ediff-update-diffs`) will recompute all the diffs in both files, just as if you had quit and re-invoked your Ediff command.

Sometimes a single diff can be quite large and you only want to copy bits of it from one file to the other; in this case the `a` or `b` commands would require you to do a bunch of manual editing after the copy. When this happens, the `=` (`ediff-inferior-compare-regions`) command can help. It invokes a new, recursive, Ediff session on just the text of the current diff, within which you can copy the individual smaller differences using `a` and `b` commands. When you're done, quit this recursive Ediff with `q`, and you're back in the parent Ediff, ready to continue.

Merging

Your version control system will frequently need you to manually merge two conflicting files (typically from two branches); so will file synchronizers, like Syncthing and Unison[402] and some operating system package managers[403]. The family of Ediff Merge commands is the way to perform these tasks.

In Figure 56, I've invoked:

```
M-x ediff-merge RET brecht1 RET brecht2
```

[402] I use both of these.

[403] Like Arch Linux's `pacdiff(8)`.

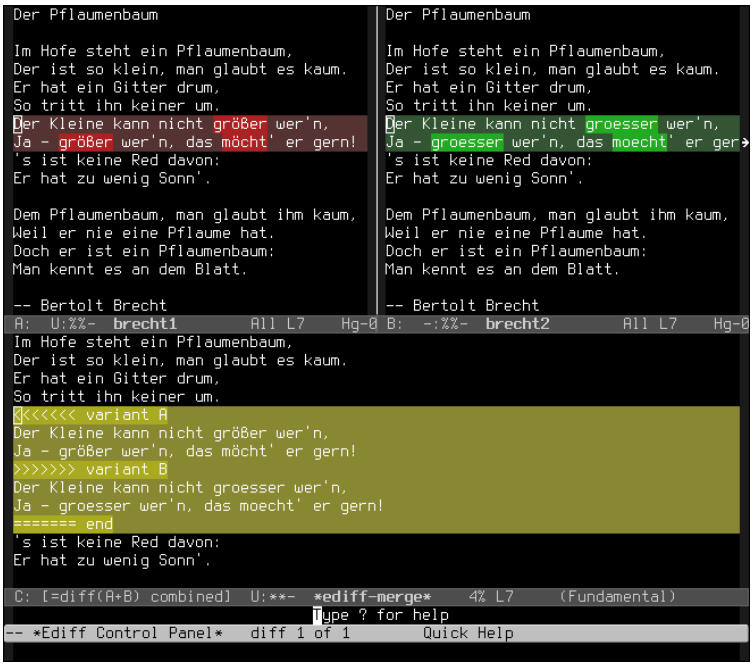

Figure 56: *Der Pflaumenbaum* Ediff Merge

It looks like the `M-x ediff` command of Figure 55 but with an extra window, called C, which is the result of the merge. In this example, Ediff has no way of guessing whether you'd prefer variant A or variant B so it shows you both possibilities in Buffer C. If you prefer one or the other, just use the `a` or `b` commands. With `M-x ediff`, those commands update either the A or B buffer, but with `M-x ediff-merge`. they update the C Buffer.

In the simplest case, you can just step through all the diffs between the two files, choosing one from A or one from B in each case. When you're done, you quit with `q` (`ediff-quit`) and then you can switch to the C Buffer—your merge—and save it to a file.

Note that if you use neither the `a` nor the `b` command for a given diff, the result of the merge will be the literal text you see in Buffer C, in our example:

```
<<<<<<< variant A
Der Kleine kann nicht größer wer'n,
Ja - größer wer'n, das möcht' er gern!
>>>>>>> variant B
Der Kleine kann nicht groesser wer'n,
Ja - groesser wer'n, das moecht' er gern!
======= end
```

with the <<<< and >>>> characters and all the rest. You can jump into Buffer C to delete any of these bits, or mix and match the two variants however you like (perhaps you want to keep the "größer"'s

but use the "moecht" with them).

When you finish the merge with `q` (`ediff-quit`), Buffer C, actually called `*ediff-merge*`, is the result of your merge: you generally want to save it to a file with `C-x C-w` (`write-file`).

If you expand the `*Ediff Control Panel*` you'll see that there are a few extra commands to help with merging.

Ediff Merge Entry Points

There are several entry points to the Merge subsystem; most are analogous to the Ediff entry points. But take special note of the `-with-ancestors` variants. When the two files you're merging are related to a common ancestor (typical with version control system merges), you can use these variants and Ediff will be able make educated guesses about which variant, A or B, to prefer.

Table 65: Ediff Merge Entry Points

`M-x ediff-merge`	merge two files
`M-x ediff-merge-files`	... the same
`M-x ediff-merge-files-with-ancestor`	... taking an ancestor into account
`M-x ediff-merge-with-ancestor`	... the same
`M-x ediff-merge-revisions`	merge this file with an older revision
`M-x ediff-merge-revisions-with-ancestor`	... taking an ancestor into account
`M-x ediff-merge-buffers`	merge two buffers
`M-x ediff-merge-buffers-with-ancestor`	... taking an ancestor into account

Integrating Ediff into External Programs

Version Control Systems and such often have a configuration file in which you can specify your *merge tool*. You can set this to be Emacs running `ediff-merge` or, better, `ediff-merge-files-with-ancestor`. Here are two examples of how I do this.

First, for my version control system, Mercurial, I have this stanza in my config file:

```
[merge-tools]
emacs.executable = emacs
emacs.args = --no-desktop --eval '(ediff-merge-files-with-ancestor "$local" "$other" "$base" nil "$output")'
```

The magic strings `$local`, `$other`, `$base`, and `$output` are replaced by Mercurial with appropriate file names when it invokes Emacs. See *Starting Emacs!* for information about `--eval`.

I use Unison as one of my file synchronizers, and this line in its preferences file does the job:

```
merge = Name * -> emacs --no-desktop --eval '(ediff-merge-files "CURRENT1" "CURRENT2" nil "NEW")'
```

Here the magic filenames are `CURRENT1`, `CURRENT2`, and `NEW`. Note that Unison doesn't provide an ancestor file when it invokes the merge tool, so I use a different Emacs function.

Also note that I invoke `emacs` here, with `--no-desktop`, rather than `emacsclient`. I used to use `emacsclient` for a quicker startup but I found it to be too confusing in the already confusing context of file merging—I prefer a totally clean, empty Emacs! You could invoke `emacs` with `-q` instead, which will skip loading your Init File and get a very fast startup, as long as you can cope with an uncustomized Emacs. (My Emacs is so heavily customized that I can barely remember how to use an Emacs invoked with `-q`, but YMMV.)

Comparing and Merging Directories

You can also Ediff two directories, comparing all pairs of files that have the same basename. You could of course just manually run `M-x ediff-files` on every pair of files yourself, but it would be easy to miss a pair, or forget where you left off after a break. The Ediff Directories subsystem does all the bookkeeping for you.

When you fire up `M-x ediff-directories`, you'll be asked if you want to narrow the files to be considered via a Regular Expression; just hit `RET` if you want to consider all possible files.

You'll be presented with a Buffer called `*Ediff Session Group Panel*` which lists all the pairs of corresponding files; each pair is called a *session* because you'll (potentially) be doing a complete diff or merge on it. `?` expands a helpful menu of Session Group commands (see Table 66).

Table 66: Ediff Session Group Commands

`D`	Prep	show differences among directories
`= =`		for each session, show which files are identical
`= h`		like ==, but also marks sessions for hiding
`h`	Hiding	mark session for hiding (toggle)
`x`		hide marked sessions
`C-u x`		unhide marked sessions
`u h`		unmark all sessions marked for hiding
`= h`		like ==, but also marks sessions for hiding
`RET`	Session	start Ediff session at Point
`v`		. . . the same
`q`		quit this session group
`m`	Marking	mark session for a non-hiding operation (toggle)
`u m`		unmark all sessions marked for operation
`= m`		like == ==, but also marks sessions for operation
`P`		collect custom diffs of all marked sessions

You generally want to start by preparing your Session Group. `D` (`ediff-show-dir-diffs`) pops up a new Buffer that shows you the remaining files in the two directories that *don't* have corresponding names. You might want to copy any one of them to the other direc-

tory, which you can do with a simple `C` command in this Buffer.

We now want to *hide*, i.e. exclude from diffing, as many files as possible.

You should run `= h` (`ediff-meta-mark-equal-files`), which will do a quick comparison of the pairs of files in all the sessions, and mark, for hiding, the ones that are identical (why waste time running Ediff on these pairs?).

You should now mark for hiding any non-identical pairs that you're just not interested in. A good example would be a version control subdirectory (like a `.git` or `.hg` directory). Just navigate to these pairs and hit `h` (`ediff-mark-for-hiding-at-pos`).

Now hide all those pairs with `x` (`ediff-hide-marked-sessions`), and you're ready to start Ediffing. Just navigate to each pair in turn and hit `RET` to fire up a normal Ediff session. When you're done (having quit the diff session with `q`), you'll be taken back to the Session Group and that Session will be marked as finished.

You can also mark pairs with the Mark commands and then run `P` (`ediff-collect-custom-diffs`) to get a simple Diff Buffer giving you an overview of the differences amongst all the marked files. This is also a handy way of generating a patch.

If your selected pairs include any directories, they will be diffed recursively, creating their own Session Groups.

The bookkeeping done by the Session Groups is invaluable for managing an otherwise tedious and annoying task. You can easily take a break from diffing and rejoin your sessions again later; just run `M-x ediff-show-registry`. The Ediff Registry shows you all Ediff sessions you have running. Sadly however, Ediff sessions aren't preserved if you quit your Emacs (not even if you're using Desktop Mode).

There are several other entry points, which determine which Ediff command is used on each pair of files.

`M-x ediff-directories`	diff common files in two directories
`M-x ediff-directories3`	diff common files in three directories
`M-x ediff-directory-revisions`	… only files under version control
`M-x ediff-merge-directories`	merge common files in two directories
`M-x ediff-merge-directories-with-ancestor`	… using ancestors from a third directory
`M-x ediff-merge-directory-revisions`	merge common files in two directories
`M-x ediff-merge-directory-revisions-with-ancestor`	… with ancestors

Table 67: Ediff Directories Entry Points

Patching

In addition to merging, there's also *patching*. Suppose Amy and Bridget each have a copy of the file `foo`. Amy makes some changes to `foo` that Bridget wants, and instead of giving Bridget the changed file, Amy gives Bridget a diff[404] of Amy's old `foo` against her new `foo`. In this context, the diff output is called a *patch*, and Bridget wants to

[404] I.e., the output of `diff(1)`.

apply the patch to her own `foo` in order to transform it into Amy's new version.

This may sound crazy—why doesn't Amy just give Bridget the new `foo`? But this actually does happen fairly frequently, especially when Amy and Bridget are programmers working on a program together, or system administrators dealing with a security patch that needs to be quickly applied. Bridget may have made her own changes to `foo` which she wants to keep; applying Amy's patch preserves Bridget's changes while applying Amy's (unless there are line by line conflicts).

A single patch often contains diffs of several files and all should be applied at once. Applying patches used to be a lot of work until Larry Wall wrote `patch(1)`. Ediff has a helpful interface to `patch(1)`.

Either of `M-x ediff-patch-file` or `M-x ediff-patch-buffer` will run `patch(1)` and then pop up an Ediff showing you the changes that have been applied[405]. You can approve the changes or make any necessary tweaks.

[405] It effectively diffs the `.orig` file `patch` creates against the newly patched file.

Emacs also makes it easy to *generate* a patch for one file. You can do it from Dired: just mark the pair of files you want to be in the patch and say `!` (`dired-do-shell-command`) with the command `diff -u *` and then save the `*Shell Command Output*` Buffer to a file (or email it directly from Emacs). The easiest way to generate a patch containing multiple files is from the `ediff-directories` Session Group Buffer.

Emerge

Emacs has another, older, subsystem for merging files called Emerge. All the Emerge commands begin with `emerge-`; don't confuse the two. Personally I think the Ediff Merge subsystem is far superior, and I haven't used Emerge in years, but it *is* a powerful system in its own right. YMMV.

Simple Window Comparison

You can also do a simple comparison of two windows with `M-x compare-windows`. Arrange your Frame so it's only displaying the two Windows you want to compare. In each Window, set Point at the beginning of the part of the text you want to compare (perhaps just do `M-<` (`beginning-of-buffer`) in each). Now invoke `compare-windows`.

Point in each Window will be moved to the first spot in each Window where the two Buffers differ. Reinvoking `compare-windows` jumps to the next difference. In between invocations you can make

any changes you like in either Window.

With a prefix argument, `compare-windows` will ignore differences in whitespace.

In writing this description I discovered that this apparently simple command is really quite complex and powerful; see `M-x customize-group compare-windows`.

References

- Free Software Foundation. 2021. *Comparing and Merging Files.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/diffutils/manual/diffutils.html`. Read in Emacs with `M-x info-display-manual RET diffutils RET`.

- Free Software Foundation. 2020. *Ediff.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/ediff.html`. Read in Emacs with `M-x info-display-manual RET ediff RET`.

Playing Music

Another application domain for Emacs is as a music player. This mostly means playing from a collection of audio files (mp3s, flacs, oggs). Nowadays most people use commercial streaming services (Spotify, Bandcamp, YouTube, Amazon, etc) to play music and may well own neither any audio files nor even physical CDs or vinyl; while there are a few Emacs interfaces to such services, the very idea goes against the grain of the Emacs predilection for free and open file formats and protocols. If you own your own data, no corporate entity can take it from you, start charging you (more) money or inflicting more ads, or just vanish in a corporate bankruptcy.

Audio data is complex and multifarious, and I know of no Emacs packages that manipulate the data directly in Elisp.[406] That means that Emacs music players are generally interfaces to external programs that you'll need to install via your operating system's package manager.

[406] I actually find that very surprising...

EMMS: Emacs Multimedia System

My preferred music player is EMMS, the Emacs Multimedia System. It has a 4,257-line Info manual, will work with almost any audio players you happen to have installed, and is perhaps the most Emacs-native of all the music players I've tried: that is, it's well-integrated with other Emacs systems, lets you manage its buffers and windows however you like (rather than requiring a bespoke multi-paned layout), is massively customizable, and everything about it is plain text.

First you need to use your operating system's package manager to install at least one audio player. If you don't already have a preference, I recommend just installing `mplayer`, since it plays some 200-odd audio formats. (But see below for MPD.)

Next, you need to install EMMS itself via the Emacs package manager. Just give this command once:

```
M-x package-install RET emms RET
```

(See *The Package Manager* for more information, including updating

your packages.)

Now you need to configure EMMS in your Init File. You can read the disquisition in the manual, but here's a configuration I used before switching to MPD:

```
(autoload 'emms "emms" nil t nil)
(autoload 'emms "emms-browser" nil t nil)
(with-eval-after-load 'emms
  (require 'emms-setup)
  (emms-all)
  (setq emms-player-list '(emms-player-mplayer))
  (setq emms-source-file-default-directory (file-name-as-directory "~/mp3s"))
  (define-key emms-browser-mode-map (kbd "SPC") #'emms-browser-toggle-subitems-recursively)
  (when (memq system-type '(gnu gnu/linux gnu/kfreebsd))
    ;; use GNU find for extra speed when possible
    (setq emms-source-file-gnu-find "find"
          emms-source-file-directory-tree-function 'emms-source-file-directory-tree-find)))
```

You'll need to change `~/mp3s` to the directory where you keep your audio files (EMMS will work with multiple directories; this is just the default.)

Now restart your Emacs[407], and say `M-x emms-add-directory-tree`; either hit return to add your default music directory (defined above), or pick any other directory of music files (whether under your default directory, or elsewhere). This populates the default playlist with all the files in that directory (recursively). If you've chosen a directory with, say, thousands of audio files, it may take a while to populate the playlist (and especially to convert simple filenames to Artist–Title format), but it runs in the background so you can start using EMMS right away, and the data will be cached, so the next time you start up EMMS, it will all be loaded quickly.

[407] Or instead, set the region around the entire `with-eval-after-load` sexp and say `M-x eval-region`.

Now say `M-x emms` and in the `*EMMS Playlist*` buffer just move Point to the song you want to play and hit `RET`. Of course you can just use `C-s` (`isearch-forward`) or `M-x occur` or whatever you like to find your way around, until you get comfortable with the EMMS searching and browsing commands.

Be sure to check out the manual to learn the basic commands, how to work with multiple playlists, how to use the browser, display album covers and lyrics, mark tracks in playlists for bulk operations, use the tag editor to fix metadata, set bookmarks, play streaming audio and internet radio, and much more.

Music Player Daemon (MPD)

One of the most popular music players for Unix nerds is Music Player Daemon (MPD). I'm a big fan of MPD, but its disadvantage is that it's somewhat complex to set up and configure. It implements a client-server interface: the server knows about your music files and your audio hardware, and any number of clients (CLI, TUI, GUI, and Emacs) exist that can talk to the server to control it (play this track,

stop playing, randomly play all my Math Rock tracks. . .). This design means that there are many MPD clients, and that the server and client can be on different machines (so, you can use an MPD client on your phone to control the server on the Raspberry Pi that's connected to your home stereo).

If you're already using MPD, EMMS can use it instead of the above `mplayer` setup and I would recommend that; see below for a possible configuration.

Emacs also has several other MPD clients; one is built-in: `M-x mpc`.

Figure 57: `M-x mpc`

I don't like its interface: it's completely undocumented and it pops up an arrangement of five windows that I just find confusing. You can instead install `ampc` from the Package Manager[408] and run `M-x ampc` — you'll get an extremely similar bunch of windows (six this time) but `ampc` actually has documentation (do `C-h P ampc`, which you can do before installing it) and I find it less confusing. There are at least three more MPD clients in the MELPA package repository (`mpdel`, `elmpd`, and `mpdmacs`) that I haven't investigated.[409]

Here's the EMMS configuration I use with MPD:

[408] Just say `M-x package-install RET ampc RET`; you only have to do this once.

[409] And I've written two of my own (which I no longer use)!

```
(autoload 'emms "emms" nil t nil)
(autoload 'emms "emms-browser" nil t nil)
(with-eval-after-load 'emms
  (require 'emms-setup)
  (require 'emms-player-mpd)
  (emms-all)
  (add-to-list 'emms-info-functions 'emms-info-mpd)
  (setq emms-player-list '(emms-player-mpd))
  (setq emms-player-mpd-music-directory "~/mp3s")
  (emms-cache-set-from-mpd-all)
  (ignore-errors
    (call-process "mpc" nil nil nil "consume" "off")))
```

References

Free Software Foundation. 2020. *Emms Manual.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET emms RET`.

Mail and News

One of the big application domains for Emacs is as a Mail User Agent (MUA), or what we loosely call a *mailer*. Rather than using the usual web-based interface to Gmail, Outook, or the like; a traditional GUI mailer like Thunderbird; or a command-line client like Mutt; you can leverage all the things Emacs does for you by reading your mail in Emacs.

A decade or two ago, reading mail in Emacs was more common; now, when Email is a commodity run by multinational megacorporations like Google, Apple, and Microsoft, Emacs mail definitely isn't for everybody. That said, you'll have to pry my Emacs mailer out of my cold, dead hands.

Even if you don't want to commit to using Emacs as your MUA, the Emacs mailers can still be useful. I have a friend who uses Gmail as his MUA but hit the maximum space limit. Rather than pay for more space, he exported (and then deleted) all his old mail (Google uses Mbox format for this) and now happily uses Notmuch in Emacs to search and read his decade's worth of archival mail.[410] Also, internet mailing lists often make their archives available as downloadable Mbox files and Emacs makes a great browser for these.

[410] Status report: he now uses Gnus as his MUA, but still uses Notmuch for his archives.

Sending Mail

Being able to compose and send mail directly from Emacs is useful even if you don't use Emacs to *read* your mail, and it's easy to set up. If you're doing all your computing in the Lisp Machine, it's very annoying to have to paste a bunch of text into a web browser (or worse, *compose* your text directly in a browser), and probably see it get mangled into HTML in the bargain.

Configuring SMTP

There are a lot of ways to send email but the most common nowadays is *remote SMTP*. If you use Gmail, Apple, Microsoft, or the like for your email, you can use their SMTP server to send mail from

Emacs. You'll need to know:

- your SMTP server name, something like `smtp.gmail.com` or `smtp.office365.com`
- your user name
- your password

Some providers may have additional settings you need to specify (at this writing, these three are sufficient for Gmail). You may also need to tweak settings in your provider's web interface (e.g., Gmail requires you to enable mail access for "less secure apps"; be sure you understand the ramifications of this[411]).

[411] Emacs is as secure an app as your web browser; the "less secure apps" setting is about installing other apps from your phone's app store that might want to access your email. So just pay attention to app permissions if you enable "less secure apps".

You don't have to configure these via Customize or in your Init File; when you send your first email, you'll be prompted for them, and Emacs will remember your responses. However, you might want to use `M-x customize-option` to configure these two User Options ahead of time: it will save you some future typing:

`user-mail-address` your email address (to be filled-in to the emails you send) in the form `user@example.com`

`user-full-name` your name, in the form `Joe Blow`

Composing Email

Before you can send an email, you need to compose it. The basic command to pop up a mail composition Buffer is `C-x m` (`compose-mail`); it has as variants `C-x 4 m` (`compose-mail-other-window`) and `C-x 5 m` (`compose-mail-other-frame`). The Buffer is called `*unsent mail*`, will be in `message-mode`, and will be initialized with some text similar to this (you're Joe in this scenario):

```
To:
Subject:
From: Joe Blow <joe@example.com>
--text follows this line--
```

As you'd expect, this is in every way a normal Buffer with some appropriate key bindings and colorization due to `message-mode`. (The `From:` line may look strange if you haven't yet configured your email address and name, as above (you can always just edit the `From:` line manually).

Now just fill out your message: add an email address to the `To:` line (I'd recommend your own email address for this first test message, so you can tell if it worked), add a subject to the `Subject:` line,

correct the email address in the `From:` line if necessary, and type the body of your message after `--text follows this line--` (don't mess up that line, it's significant). The word "test" is sufficient as the body for this test message.

In order to send the email, you need to have network connectivity at that moment: in other words, your wifi needs to be up (if your computer doesn't have a wired Ethernet connection).

Now send the message with `C-c C-c` (`message-send-and-exit`). This first time (and this time only) Emacs will have some questions for you — probably only two:

1. `Send mail via (default mail client):`

   Enter `smtp` here.

2. `Outgoing SMTP mail server:`

   Type your mail provider's SMTP hostname here.

While this is happening, Emacs is actually negotiating with your provider's SMTP server; if the provider asks Emacs for more information, Emacs will pass those questions on to you (it will certainly ask for your user name and password here).

When you enter your password, Emacs will ask if you want to save it for later use. If you say yes, it will be saved in the file `~/.authinfo` in plain text, meaning anyone with access to this file on your computer can read it to see your password. In my opinion you should set up this file to be encrypted, and it's easiest to do this ahead of time; see *Authentication*, *Encrypted Files*, and *EasyPG Assistant* for more information.

If there are questions that you don't understand or don't know the answer to, just use `C-g` (`keyboard-quit`) to abort the sending, and read "Mail Sending" in the *Emacs* manual.

Reading Mail

The next step after sending mail is to read your mail. Emacs has half a dozen mailers to choose from, but only three are built-in, and of the three, only Gnus directly supports remote mail. Gnus is my favorite mailer and I highly recommend it, though it's not for the faint of heart.

> If you are used to traditional mail readers, but have decided to switch to reading mail with Gnus, you may find yourself experiencing something of a culture shock. — Lars Magne Ingebrigtsen, Gnus author

Properly speaking, Gnus is a *newsreader*. In this context, "news" means Usenet and its protocol, NNTP. Usenet (1980) is what preceded Internet Web Forums (and AOL, and most BBS's), and was

of tremendous cultural importance[412]. Imagine if instead of having to go to a different web site for every forum, they all came together (thanks to the open protocol NNTP) as *newsgroups* readable in your choice of many special *newsreader* programs. In addition, the newsreader would keep of track of which postings you've read in each newsgroup. No more plowing through dozens of messages you've already read to find the newest ones; no more reading in reverse order. Wow.

Since you read all these newsgroups in one program, they all had exactly the same interface (wow), and if you didn't like that interface, you could choose a different newsreader, or write your own.

The first Emacs newsreader that I used was Gnews by Matthew P. "Weemba" Wiener (definitely before 1988). At some point I switched to Masanobu Umeda's GNUS (1988-1992), which Lars Magne Ingebrigtsen rewrote under the slightly differently-spelled name Gnus in 1994.

Gnus was definitely the best newsreader I had ever used, inside or outside of Emacs. And since any single post ("news message") in a newsgroup was almost exactly like an email, Lars made it possible to just treat all your actual email as news. Your mail folders would be treated as newsgroups. Sending an email would be like posting to a newsgroup. Now you have the same interface to both news and mail, and since Gnus is the most crazily powerful and extensible news reader of all time, it makes an amazing mailer. It's possible that I've been using Gnus as my main mailer since about 1996 (with various breaks to experiment with other Emacs mailers, none of which were up to the challenge).

Gnus ships as part of Emacs and is a very large and complex system. It has a 32,642-line manual, which is very entertaining (makes great bedtime reading!), well-written, and covers everything you need to know. Figuring it all out will be something of a project... But fortune favors the bold!

[412] Usenet is still around, in a sort of underground way, and Lars generously built a free service that uses the NNTP protocal to allow you to read thousands of mailing lists without the bother of actually subscribing to them.

Other Emacs Mailers

There are half a dozen other mailers to choose from; most of them are third-party packages but three are built-in. All of these mailers, listed here from oldest to newest, are completely usable if they meet your requirements. My recommendations below are strictly personal preference. But first, some terminology.

Remote Mail This is the normal way people read mail nowadays. Some service provider, like Gmail or Outlook, receives and hosts your mail for you, which you read "remotely". That is, your MUA (say, the Gmail app on your phone) fetches each email over the

network each time you click to read it: you don't actually have copies of all your mail. The protocol that enables remote mail is called *IMAP*.

Local Mail This means that your mail is delivered directly to your computer, the messages are stored on your local disk, and your MUA never makes a network connection (except to send). This is the way email originally worked when people logged into servers from terminals. It assumes your computer is always on because mail can arrive at any moment (and if your computer is down, the mail will bounce), and so usually only servers with system administrators do this. But there's a hybrid approach: you can use a *Mail Retrieval Agent (MRA)* to fetch your mail from a remote provider (like Gmail) to your computer's disk, as if it had been delivered there directly; examples of MRAs include `msmtp`, `movemail`, `isync`, `mpop`, `fetchmail`, and `offlineimap`.

The Mailers

Some of these mailers don't do the IMAP protocol; using them may require a certain amount of comfort with installing and running external software, and setting up an ecosystem where you can read your mail both in Emacs and also on your phone can be something of a challenge, depending on how particular you are.

Rmail The oldest Emacs mailer (1985; it actually predates GNU Emacs and was present in ITS TECO Emacs in 1975); built-in; still supported and updated; only local mail is supported. Rmail is pretty basic, but if you configure your MRA to split your mail into reasonably-sized folders, that may be sufficient for your needs. Even if you don't commit to Rmail as your MUA, it makes an excellent browser for random Mbox files you may have laying around (like those you can download from mailing list archives).

MH-E A front-end to `nmh`, the "modern" replacement for the Rand Mail Handler (MH), a historic (1979) command-line MUA. MH-E is a mature program last updated in 2016. The Emacs package is built-in, but depends on `nmh` being installed. Local mail only. Not recommended.

VM A mature program last updated in 2010; neither built-in nor available in the package manager; needs to be manually installed. Both local and remote mail are supported. Not recommended.

Mew A very nice MUA with a lovely Mime composition facility; probably my second-favorite Emacs mailer, though I haven't

used it for many years. Both local and remote mail are supported. Available in the package manager from MELPA.

Wanderlust A capable MUA; both local and remote mail are supported. But it's not in the package manager and is typically installed outside of Emacs via the OS package manager (available to my knowledge on Arch Linux and FreeBSD at least); depends on three other Elisp packages that are also not available in the package manager. I find that this means that Wanderlust easily goes out-of-sync with Emacs updates and for this reason I don't recommend it.

Notmuch A very unusual, elegant, and minimalist mailer based completely on search, with tagging completely replacing folders; available in the package manager from MELPA. The downsides are that Notmuch depends completely on a standalone command-line application (called `notmuch`) which indexes, searches, and manages the tags, and that it does local mail only.

Mu4e Similar in design to `notmuch`, but based on the `mu` mail indexing program. Local mail only. Same caveats as Notmuch. (I haven't ever used this mailer, but it's well-liked.)

Browsing Mbox Files

Even if you aren't using Rmail as your mailer, `rmail-mode` makes an excellent Major Mode for viewing Mbox files, if you happen to have any. You can make this your default with this Init File snippet:

```
(add-to-list 'auto-mode-alist '("\\.mbox\\'" . rmail-mode))
```

References

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  See also the chapter *Reading Mail with Rmail* in the Emacs manual.

- Reid, Brian, Stephen Gildea, Jim Larus and Bill Wohler. 2016. *The MH-E Manual.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/mh-e.html`. Read in Emacs with `M-x info-display-manual RET mh-e RET`.

Web and News Feeds (Syndication)

News web sites and blogs update on a regular basis, adding new headlines, stories, or posts periodically. It can be overwhelming to have to check many such sites on a daily basis; besides the sheer amount of time required to visit them, new items you might be interested in can be deeply buried and easily missed. Somebody should do something about this!

Somebody did! Many such sites use *web syndication* to publish a *feed* of the new items on their site (such feeds are often loosely called "RSS feeds"). Using a tool called a *news aggregator* or *feed reader*, you can subscribe to these feeds and see all the updates, from possibly hundreds of sites, in one central sorted list of headlines. Click on a headline to see a summary (sometimes the complete content) of the web site's update or jump directly to it in your web browser. You can typically sort the headlines in various ways, categorize the web sites, and more.

To browse a personal collection of feeds, you need a feed reader. The most popular feed readers historically have probably been web sites that offer aggregation as a service, with all the drawbacks this entails. Some require payment in the form of a monthly subscription; many are ad-supported; and like any service, it may disappear at any moment.[413] (Google Reader was one of the most popular such feed readers, but Google yanked the plug after half-a-dozen years, leaving their customers in the lurch.)

You can avoid all this by running your own feed reading software, and of course Emacs is ready with several.

Your job, with any feed reader, is to add the URLs of the feeds you're interested in, and the reader does the rest, groveling all your feeds for updates whenever you start it up.

Sites that syndicate their content usually indicate this with a link, often buried at the bottom of the home page, that says something like "RSS feed" or "Atom feed"[414], or perhaps just the standard web feed icon. Sometimes it can take some hunting to find a feed link; it might be buried in an About or Contact page.

[413] See `https://killedbygoogle.com/` for examples.

Figure 58: Web Feed Icon

[414] RSS and Atom are the two main syndication data formats.

Newsticker

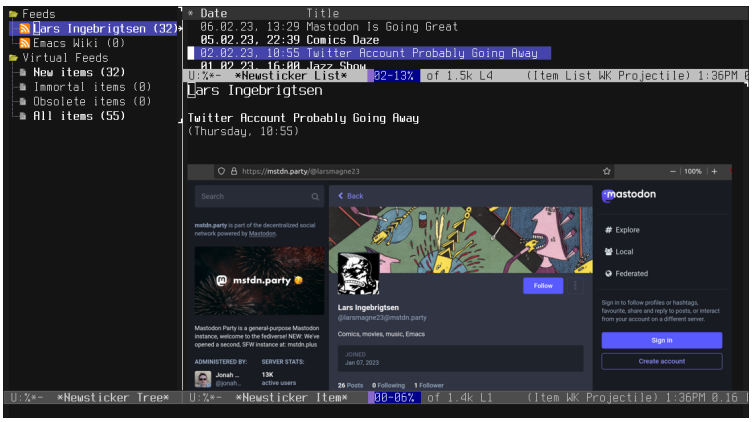

Figure 59: Newsticker Feed Reader

The main built-in Emacs feed reader is Newsticker. Just run `M-x newsticker-show-news` and it will pop up the three panel view seen in Figure 59. By default, it comes populated with just the EmacsWiki news feed; here I've added Gnus author Lars Ingebrigtsen's blog feed and have popped up one of his posts. Lars's feed includes the complete contents of each of his blog posts, so I actually never need to visit his web site! But many other feeds just have a bare-bones summary[415]; in this case typing `v` (`newsticker-treeview-browse-url`) will pull up the web page corresponding to the feed entry via Browse URL. As usual, `C-h P` (`describe-package`), `M-x customize-group`, and `C-h m` (`describe-mode`) from any of the Newsticker Buffers will explain all.

[415] And some lazy sites don't even have a summary, just a headline…

Other Feed Readers

You can also use Gnus, the Emacs mailer, to read web feeds, and that's great because of the automatic deep integration with all of Gnus's amazing capabilities, but I have to admit there's a fatal flaw: Gnus has to fetch all your feeds synchronously, which means the more feeds you add, the slower it is to update them. Somebody needs to write an asynchronous back-end. So unless you're both already using Gnus for your mail (and hence completely comfortable with it) *and* only want to browse a small number of feeds (say, a dozen), I can't recommend it.

I switched from reading feeds in Gnus to the third-party `elfeed` package from Christopher Wellons. It's very fast; I'm using it for over 70 feeds at the moment and it updates them in a few seconds. It caches every feed entry you've ever looked at, so you can go back to anything at any time (even if the feed entry has disappeared from the

original web site)[416]; I've been using it for several years and it's only using 54M of disk space to preserve all those years of data. There are several third-party add-ons available, such as one for playing videos from Youtube RSS feeds.

[416] The complete opposite of having something like Google Reader yanked out from under you.

UNFINISHED *Podcasts*

UNFINISHED *Slideshow Presentations*

UNFINISHED *Address Book: The Insidious Big Brother Database (BBDB)*

UNFINISHED *Drawing Pictures*

Picture Mode

Artist Mode

UNFINISHED *DNS Lookups*

UNFINISHED *EUDC: Emacs Unified Directory Client (LDAP)*

References

Free Software Foundation. 2022. *Emacs Unified Directory Client.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET eudc RET`.

UNFINISHED *FTP (File Transfer Protocol)*

UNFINISHED *Accessing SQL Databases*

Editing Processes with `proced`

Every Unix user needs a *system monitor* or *process viewer* to monitor running operating system processes—what process is using most of my CPU? my memory?—and interact with them (e.g., to pause or kill them).

Combinations of command-line programs like `ps(1)`, `kill(1)`, `pkill(1)`, and `pgrep(1)` can handle these tasks, but most people prefer a dynamic tool like `top(1)` or the popular `htop(1)`. The native Emacs equivalent is `M-x proced`, the "process editor".

This is not to be confused with the `*Process List*` Buffer generated by `M-x list-processes`, which is specialized for interacting with asynchronous processes spawned by your Emacs. Some of these are external system processes that you can *also* see via `proced`, but `list-processes` knows how Emacs sub-processes are connected to your Emacs via Process Buffers, and also includes Emacs network connections in its purview. See *Managing Asynchronous Processes*.

But back to `proced`. When you fire it up, you'll see a `*Proced*` Buffer that will look something like the below (for clarity I've elided some overlong argument lists, dozens of self-similar Firefox sub-processes,[417] and other boring processes).

[417] Which are actually using the vast majority of my memory.

Table 68: `*Proced*` Buffer

User	PID	%CPU	%MEM	Start	Time	Args
keith	111343	1.3	7.2	Feb 1	03:40:30	/usr/lib/firefox/firefox
keith	890703	1.1	4.2	Feb 8	01:56:21	/usr/lib/firefox/firefox -contentproc
keith	1038	0.8	13.0	Jan 31	02:21:56	emacs
keith	1262	0.5	0.5	Jan 31	01:30:04	xmobar
keith	885	0.1	0.2	Jan 31	10:02	/usr/bin/mpd –systemd
keith	1043	0.0	0.1	Jan 31	05:44	herbstluftwm –locked
keith	1027	0.0	0.0	Jan 31	04:01	xautolock -locker xtrlock
keith	1454647	0.0	0.1	14:35	00:00	dunst
keith	1019	0.0	0.0	Jan 31	00:43	unclutter
keith	2138	0.0	0.0	Jan 31	00:30	/usr/bin/gpg-agent –supervised
keith	909	0.0	0.2	Jan 31	00:21	/usr/bin/pulseaudio
keith	1739	0.0	0.1	Jan 31	00:02	/usr/bin/aspell -a -m -d en_US
keith	7791	0.0	0.1	Jan 31	00:01	/usr/bin/dirmngr –supervised
keith	878	0.0	0.1	Jan 31	00:00	/usr/lib/systemd/systemd –user
keith	905	0.0	0.0	Jan 31	00:00	ssh-agent
keith	1062639	0.0	0.1	Feb 9	00:00	/bin/zsh -i
keith	239379	0.0	0.1	Feb 2	00:00	ssh ocaml
keith	1346	0.0	0.0	Jan 31	00:00	/usr/bin/alsactl monitor default
keith	447137	0.0	0.0	Feb 4	00:00	emacsclient -c

By default, the Proced Buffer shows all system processes owned by you, the user who's running Emacs, but you can change that

with a keystroke to see all processes. By default, the list is sorted on the `%CPU` column; since `proced` uses `tabulated-list-mode`, you can sort on any column. The process list is updated every 5 seconds, and there are several predefined formats featuring more attributes (columns), up to 31 on my Linux system.

Surely you'd prefer to see this information in color. I recommend this for your Init File:

Init File

```
(setopt proced-enable-color-flag t)     ; colorful proced
```

Besides observing processes, `proced`'s *raison d'être* is signaling (or renicing) processes; the approach will be familiar from Dired and the like: you *mark* the processes you want to signal, and then do so, choosing the signal to send with `k` (`proced-send-signal`).

I've grouped the `*Proced*` commands into four major categories: commands that change the display, commands that change the sort, commands to mark and unmark processes for actions, and the actions themselves.

Table 69: `proced` Commands

Category	Key	*	Action
Display	`f`		Filter processes according to *SCHEME*
	`F`		change buffer Format (verbosity / columns)
	`o`	*	Omit this process
	`T`		toggle Tree view
	`g`		refresh process list (revert)
	`RET`		refine process list according to this process
Sort	`s S`		choose a column to sort on
	`s c`		sort by CPU percentage
	`s m`		sort by Memory percentage
	`s p`		sort by PID (process ID)
	`s s`		sort by Start time
	`s t`		sort by total run Time
	`s u`		sort by process owner (User)
Marks	`m`, `d`		Mark this process
	`M`		Mark *all* processes
	`C`		mark the Children of this process
	`P`		mark the Parent of this process
	`u`		Unmark this process, moving forward
	`DEL`		Unmark this process, moving backward
	`U`		Unmark all processes
	`t`		Toggle marks
	`C-/`		Undo mark changes
Kill / Renice	`k`, `x`	*	Kill (signal) this process
	`r`	*	Renice this process
Quit	`q`		Quit (hide) the `*Proced*` buffer

Commands marked with an asterisk (∗) follow the Dired model to determine which processes the action applies to:

- the next *N* lines if a numeric argument is given, else
- the *marked* processes, or finally
- the process on the current line (where Point is).

Commands That Change the Display of Processes

The list of process is normally a flat list sorted on some column (see below) but you can also toggle a *tree view* with `T` that groups by parent-child relationship. You can *omit* uninteresting processes from the Buffer with `o` (`proced-omit-processes`), and force a refresh of the list by reverting the Buffer with `g` (`revert-buffer`); a forced refresh (as opposed to the automatic refresh that happens (by default) every 5 seconds) will discard any *refinement* or omissions. You can toggle whether or not this automatic refresh happens with `M-x proced-toggle-auto-update`.

Filtering the ∗Proced∗ Buffer

The `f` (`proced-filter-interactive`) command prompts you for a *filter scheme*; see Table 70. (The default is `user`.) This determines how many rows you see.

Table 70: ∗Proced∗ Buffer Filter Schemes

Name	Meaning
`user`	all processes owned by the Emacs user
`user-running`	... which are currently running
`all`	all system processes
`all-running`	... which are currently runnning
`emacs`	all processes descended from this Emacs

Formatting the ∗Proced∗ Buffer

The `F` (`proced-format-interactive`) command prompts you for a *format scheme*, one of `short`, `medium`, `long`, and `verbose`. (The default is `short`.) This determines how many and which columns are present.

You can add your own format scheme or tweak any of the existing ones with `M-x customize-variable RET proced-format-alist`.

Marking Processes

Marking and unmarking processes is done as per `Dired`, primarily with `m` (`proced-mark`) and `u` (`proced-unmark`). Unusual marking

commands include `C` (`proced-mark-children`) to mark all the children of the process on the current line; for example, I could easily omit all 20 of my Firefox container processes by moving to the parent process, hitting `C` to mark its children, and then using `o` (`proced-omit-processes`) to omit them from the Buffer. If instead I want to *focus* only on the Firefox containers, then after `C` I could toggle the marks with `t` (`proced-toggle-marks`), and then use `o` to omit all the non-Firefox processes.

Killing and Renicing

Unix defines a set of 20-odd *signals* that can be sent to processes, typically to terminate or pause them. Sending a signal is colloquially known as *killing*, and the `k` (`proced-send-signal`) command prompts you for the signal you want to send to the process on the current line, or the marked processes.

Processes also have a *priority*, known as *niceness* – the nicer the process, the lower its priority, and therefore the slower it runs and the less it impacts the performance of your system (how nice!). Changing the niceness of a process is known as *renicing*, and you can do it with the `r` (`proced-renice`) command.

UNFINISHED *Unix Manual Pages*

UNFINISHED *Calc*

Interactive Tutorial

Embedded Mode

Unit Conversion

`calc` knows many different units: meters and inches and feet; liters and fluid ounces; days, weeks, and years and hours, minutes, and seconds; miles per hour; and furlongs, footlamberts, and muon rest masses, among about 150 more (say `u v` when in `calc-mode`).

References

Gillespie, Dave. 2020. *The GNU Emacs Calculator.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/calc.html`. Read in Emacs with `M-x info-display-manual RET calc RET`.

There's an Emacs Calc Reference Card.

Passwords and Password Managers

Despite the ubiquity of mobile phones and new biometric methods of identification, people still need new passwords all the time. This leads to two kinds of tools: *password generators* (because people suck at making up good passwords), and *password managers* (because people suck at remembering good passwords).

A password manager stores your many passwords and *passphrases*[418] in an encrypted form, which means that you really only need to remember one very strong password to unlock (decrypt) the password manager. This allows you to use unmemorable passwords for all your web logins—especially if your password manager will usually enter (type in) the passwords for you.

The passphrase for your password manager needs to be strong, and you need to be able to remember it! Believe it or not, the best advice for how to choose a good passphrase is in this xkcd comic. However, since it's 13 years old now, you probably want to use more than four words: I'd recommend five or six[419].

Theoretically, all you need for a password manager is one file (probably an Org Mode file so you can use an outline structure with tags) that you encrypt with *EasyPG Assistant*, though this won't automatically enter passwords into websites for you.

This Unix command implements the xkcd password algorithm; Unix users can run this command repeatedly in `M-x shell` until they get a passphrase they like:

```
echo $(grep -v "'"  /usr/share/dict/words | shuf -n 6 | tr A-Z a-z)
```

It's important to include the spaces in your passphrase (though you can replace them with some other punctuation character if you like).

Emacs has both fancier password generators and password managers, but none are built-in. I haven't used any of these third-party packages myself; you can read about them via `C-h P` (`describe-package`).

[418] A passphrase is just a long, multi-word, version of a password.

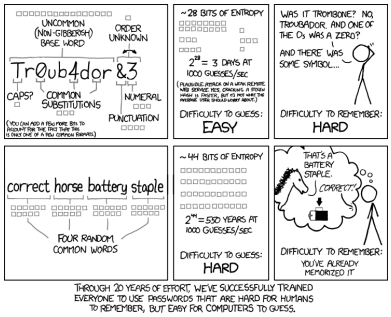

Figure 60: Password Strength

[419] Passwords can be cracked faster every year... stupid computers...

Password Generators

`password-generator` "password generator for humans"

`dw` Diceware passphrase generation commands

`totp` generate Time-based One-time Passwords (TOTP), like Google Authenticator

The Diceware home page is an excellent source of information about passwords and security.

Password Managers

The `espy` package implements the "encrypted Org Mode file" password manager I described with some simple helper functions around it. The rest of the third-party password managers are front-ends to `pass(1)`, "the standard Unix password manager". I use `pass(1)` myself, though it works fine for me with just Dired as my Emacs interface.

`pass` major mode for `password-store`

`passmm` a minor mode for pass (Password Store)

`password-store` password store (pass) support

`password-store-otp` password store (pass) OTP extension support

EasyPG Assistant

Emacs transparently edits encrypted files via the external program GNU Privacy Guard (GnuPG)[420], and the Emacs interface to GnuPG is called EasyPG Assistant, or EPA for short[421].

Perhaps you don't need to encrypt your files in general, but if you need to frequently enter passwords in Emacs, perhaps for remote file editing via Tramp, editing files via `sudo(8)`, or authenticating yourself to various network services (like your Emacs Email client), then you might want to store your passwords in a file so that you don't have to re-type them constantly, and in my opinion such a file needs to be encrypted[422]. I'll send you to the *Authentication* chapter for how to store your passwords, but that chapter will have to send you back here for how to encrypt them!

GnuPG is all about *public-key cryptography*[423]. Public-key encryption is a complex topic, and GnuPG is an extremely complex program: I can't cover it adequately here. See *The GNU Privacy Handbook* for complete details. But if you're already set up to use public-key, Emacs can make using it easier.

If not, GnuPG also handles old-fashioned *symmetric-key cryptography* as well, which is much easier to understand and doesn't require complex setup, and while public-key is much more powerful, and easier to use once set up, symmetric-key is perfectly adequate for encrypting files that you don't need to share with others.

Symmetric-key cryptography simply means that you use a password to encrypt some text, and the same password is also used to *decrypt* the text: probably that's exactly what you expected when you saw the word "cryptography"!

On Passwords

For symmetric-key encryption, you'll need to make up one or more passwords or *passphrases*. It's okay, IMHO, to use the same passphrase for several (or all) of your personal symmetrically-encrypted files[424], but it *is* definitely more secure to use a distinct passphrase for each: however, this is a hassle and requires you to use a password man-

[420] You'll need to install GnuPG via your operating system's package manager.

[421] The name of the program is GnuPG but the installed command is usually `gpg(1)`.

[422] Though Emacs doesn't insist on this; EIPNIF.

[423] One of the most important mathematical breakthroughs of the 20th century, IMHO.

[424] With public-key encryption you're effectively using the same passphrase for all your files, too.

ager.[425] (Using public-key encryption obviates the need for a password manager, at least for your files.) See *Passwords and Password Managers* for hints on password generation.

[425] Which presumably you're already using for all your web accounts.

Symmetric-Key Operations

If you haven't set up public-key encryption, you can still use GnuPG to encrypt files.

Creating A Symmetrically-Encrypted File

To create a brand new symmetrically encrypted file, simply visit a file with a `.gpg` extension tacked onto any other extension you might want, e.g. `C-x C-f foo.org.gpg`. When you save this new file, a window will pop up listing the contents of your GnuPG *public-key ring*, but the list will be empty if you haven't configured public-key encryption, and the entirety of the buffer will look like this:

```
Select recipients for encryption.
If no one is selected, symmetric encryption will be performed.
- 'm' to mark a key on the line
- 'u' to unmark a key on the line
[Cancel][OK]
```

Without a public-key ring, there are no recipients to select, but that's alright. Just click the `[OK]` button and Emacs will use symmetric encryption for this file. You'll be prompted for an encryption passphrase (be sure to remember it; you won't be able to decrypt the file without it!).

Symmetrically-Encrypting an Existing File

If you want to encrypt a file that already exists, use `M-x epa-encrypt-file`; it will prompt you for a filename and proceed as above. When you're done, you'll have an *additional* file: a new encrypted version of the original which has a `.gpg` extension. You should visit this file to make sure you can decrypt it, and assuming you can, you should delete the original unencrypted file with `M-x delete-file` or via Dired's `D` (`dired-do-delete`) command. It's probably best to use Dired so you can check for backup or auto-save files; you'll want to delete them too in order to avoid exposing your now-encrypted data.

Public-Key Operations

If you already have a public-key key pair set up with GnuPG, you can use EPA to do additional operations. See *The Least to Know About Public Key Cryptography* if you want to set it up.

Encrypting and Decrypting Files

Encrypting a file with public-key is mechanically the same as with symmetric-key; the only difference is that your public-key ring will be populated with at least your own public key, and possibly more, so the Buffer that pops up when you initiate encryption will look something like this[426]:

[426] For the sake of avoiding spam I've elided the 100-odd keys for non-corporate individuals from my key ring.

```
Select recipients for encryption.
If no one is selected, symmetric encryption will be performed.
- 'm' to mark a key on the line
- 'u' to unmark a key on the line
[Cancel][OK]

u 5DA89C7DECA0D55A Keith Waclena <keith at lib.uchicago.edu>
e 57D15AB98548EF3A The University of Chicago Network Security Center <security@uchicago.edu>
- 15D68804CA6CDFB2 FreeBSD Security Officer <security-officer@FreeBSD.org>
- F8B506E4A1694E46 The SANS Institute <sans@sans.org>
e 064973AC4C4A706E NetBSD Security Officer <security-officer@NetBSD.org>
- 9E98BF3210A792AD Bacula Distribution Verification Key (www.bacula.org)
```

If you mark one or more of the keys in the Buffer, public-key encryption will be used.

But which key? If you want to encrypt a file so that only *you* can decrypt it, simply mark your own key. If you want to encrypt it so that only one other person can decrypt, you need to have their public key in your key ring and mark it. Thanks to public-key encryption, there's no need to somehow transmit the password used to decrypt this file to the recipient: they just decrypt it with their own private key. Not even you, the sender, can decrypt this file.

How do you get someone else's key in your ring? You need to *import* it. See *Importing and Exporting Public Keys*.

In addition to solving the password distribution problem, public-key also lets you encrypt a file for several recipients at once. Just mark the key for each recipient who should be able to decrypt the file, including your own key if you like.

Encrypting and Decrypting Regions

An encrypted file just looks like random binary data. But you can also encrypt just one or more portions of the file's contents, in which case it will look something like this:[427]

[427] Confusingly, "PGP" was the name of the free software that preceded GnuPG (a.k.a GPG).

```
Here's the secret information!
-----BEGIN PGP MESSAGE-----

hQEOA2k9uqIsdvCNEAP/RJfBlafF4KeqNVl3LIZHgt+6E4Inve7Vz7pNmyCfXqSA
uGotx0xJxAqhdcZSrooVMZL+oP3JsEKZPeJZkoX/oGCYg4c55Y+LSmRr76tIrqmO
vDU5qhPZz4H9PvP0hve1KyfIRjTQB7/8ZJiry/4KVlf16kDiNWVsMn5rdFlyJ98D
/ROfebRZ6zOnuC3T51chrwVjsB6xKr8sKO5pJXUXQGC7vjexRB25opsdiuNlDb64
YcodunCMy1m5jYZbatA41RVV+Qh0luTkH6JxIeSugwzHApsS+Vq3VbWgoH6pi9BQ
VnFwKqc4lCFHk8XXnSuVA1x69OFCf3uZDDUhhfBcOCYX0kABsSqaGQArxX67W+cO
M5YHvHQQoNCcbFDDzPSiQjE2AG30tU46n4th55VHujgpugniX8OteSxouX703NgU
YAOk
=k5Ze
-----END PGP MESSAGE-----
Act quickly!
```

This format is called "armored output" because it's safer to move it around (e.g. via email) than binary data (which can get corrupted). You can decrypt such data with `M-x epa-decrypt-armor-in-region`. Since the encrypted data is easily recognizable, you don't have to set the Region *precisely* around it—you could just use `C-x h` (`mark-whole-buffer`) and `epa-decrypt-armor-in-region` would decrypt any and all such encrypted bits in the Buffer. The command will ask whether to replace the armored content with the decrypted data, or to display it in a temporary Buffer.

You can create an armored encrypted Region in a Buffer with `M-x epa-encrypt-region`.

Normally, there's no need to decrypt an *unarmored* Region, because no one would insert the binary data into the middle of a file: unarmored data is always stored as the complete contents of a file. And since Emacs by default decrypts encrypted files automatically when you visit them, there's very little call for `M-x epa-decrypt-region`. But there it is, just in case.

Signing and Verifying

Besides encrypting and decrypting data, public-key cryptography can also be used to *sign* data. To sign data means to attach an incorruptible digital signature that verifies that *you* and only you sent a given email, or signed a given contract, or packaged a piece of software. You can sign an entire file, or just portions (Regions) of it.

Here's what a signed Region looks like; there's no way for me to disavow this statement:

```
-----BEGIN PGP SIGNED MESSAGE-----
Hash: SHA1

I hereby agree to use Emacs for the rest of my life.
-----BEGIN PGP SIGNATURE-----

iF0EARECAB0WIQS2KmSeImk7rnKCEDldqJx97KDVWgUCZHZSaAAKCRBdqJx97KDV
WtbbAKCLvZMwnQSJYX63njph890ws/TTbgCfcwtPU4EQ9ofOzh4C8Wx5HlqoUzc=
=lXKR
-----END PGP SIGNATURE-----
```

I created it by setting the Region around the declaration and invoking `M-x epa-sign-region`. You can verify such signed text with `M-x epa-verify-region`, which in this case will pop up a Buffer like this[428]:

[428] Assuming you have my public key in your key ring.

```
Good signature from 5DA89C7DECA0D55A Keith Waclena <keith at lib.uchicago.edu>
```

But if someone changes the text of the declaration, verification will fail:

```
Bad signature from 5DA89C7DECA0D55A Keith Waclena <keith at lib.uchicago.edu>
```

You can sign an entire file without Visiting it with `M-x epa-sign-file`.

Public-Key Ring Management

The command `M-x epa-list-keys` displays your GnuPG *public-key ring* in a `*Keys*` Buffer that will look something like this:

```
The letters at the start of a line have these meanings.
e  expired key.  n  never trust.  m  trust marginally.  u  trust ultimately.
f  trust fully (keys you have signed, usually).
q  trust status questionable.  -  trust status unspecified.
 See GPG documentation for more explanation.

  u 5DA89C7DECA0D55A Keith Waclena <keith at lib.uchicago.edu>
  e 57D15AB98548EF3A The University of Chicago Network Security Center <security@uchicago.edu>
  - 15D68804CA6CDFB2 FreeBSD Security Officer <security-officer@FreeBSD.org>
  - F8B506E4A1694E46 The SANS Institute <sans@sans.org>
  e 064973AC4C4A706E NetBSD Security Officer <security-officer@NetBSD.org>
  - 9E98BF3210A792AD Bacula Distribution Verification Key (www.bacula.org)
```

Each line has a public-key identifier, a person's (or corporate entity's) name, and usually an email address. Some lines have flags that indicate the key's *trust level*, and you'll notice I have a couple expired keys that I should update or delete. You can hit `RET` on any of these keys to get more complete information (in particular, full key fingerprints).

Table 71 lists the key management commands available in this Buffer. In addition to the usual Special Mode commands, you can

Key	Type	File?	Command
`m`	Marking		Mark this key
`u`			Unmark this key
`d`	Encrypt / Decrypt	yes	`M-x epa-decrypt-file`
`e`		yes	`M-x epa-encrypt-file`
`i`	Import / Export	yes	`M-x epa-import-keys`
`o`			export this or marked keys
`s`	Sign / Verify	yes	`M-x epa-sign-file`
`v`		yes	`M-x epa-verify-file`
`r`	Delete		Remove (delete) this key

Table 71: Commands in the EPA `*Keys*` Buffer

mark one or several keys and then give a command that will use them. (If no key is marked, the key at Point will be used.) There's a corresponding, less-used, command to list your *private-Key ring*, `M-x epa-list-secret-keys`.

The five "File?" commands in Table 71 can be used outside of the `*Keys*` Buffer via `M-x`; they will prompt you for a file to operate on and pop up the `*Keys*` Buffer if needed.

Importing and Exporting Public Keys Where do you get other people's public keys so that you can send them encrypted data? Many people make their keys available on their web site; you can just download the key as a file and then use `M-x epa-import-keys`.

You can also import someone's key from a *key server*, if the user has uploaded it to one. Just say `M-x epa-search-keys` and enter the user's name or email address. You can then mark the correct key and import it.

If you want to upload your public key to a key server, you can mark it in the `*Keys*` Buffer and type `o` (`epa-export-keys`).

There's a bit of a chicken / egg problem here: how do you know that the key on the person's web site is really *their* key? If someone else has gained control of their web site, they could have replaced the key with a different one! Such concerns are very real for journalists, dissidents, and whistle-blowers. Ideally you would get a copy of each person's public key face-to-face with an exchange of flash drives, or from their phone via Near-field communication (NFC) or the like. But usually it's good enough to compare the key on their web site with its fingerprint, as published in a separate medium, like their email signature, business card, or via a key server. See *The GNU Privacy Handbook* under "Web of Trust" for more information.

Caching Passwords Via the GPG-AGENT

When you run `gpg(1)` for the first time in a login session (or when Emacs first runs it for you), it fires up an additional program in the background called `gpg-agent(1)`. This program caches your passwords for a period of time[429] so that, if you visit an encrypted file several times in quick succession, you won't have to re-enter your password every single time.

[429] Configurable outside of Emacs in GnuPG's config file.

`gpg-agent`'s password prompt will probably come from an OS GUI popup window rather than from Emacs itself. If you'd rather have Emacs prompt you in the Minibuffer, Customize `epg-pinentry-mode` and set its value to `loopback`. You'll also need to add this entry to your GnuPG config file:

```
allow-loopback-entry
```

Encryption Commands in Dired

Performing GnuPG operations on whole files is often most easily done in Dired via the commands in Table 72; as usual they observe the Dired marks or numeric arguments.

Table 72: Encryption Commands in Dired

Key	Command
: d	Decrypt this file
: e	Encrypt this file
: s	Sign this file
: v	Verify this file

Email

In most Emacs mail user agents (MUAs), it's very easy to encrypt, sign, decrypt, and verify email messages and attachments. I haven't made a study of this in all the MUAs, but it's certainly true in the one I use, Gnus. Decrypting and verifying will just happen automatically, and encrypting and signing are a keystroke away.

References

- Free Software Foundation. 2022. *EasyPG Assistant User's Manual.* Cambridge, MA: Free Software Foundation. `https://www.gnu.org/software/emacs/manual/epa.html`. Read in Emacs with `M-x info-display-manual RET epa RET`.
- Ashley, Mike. 1999. *The GNU Privacy Handbook.* Cambridge, MA: Free Software Foundation. `https://www.gnupg.org/documentation/`

`guides.html`.

- Free Software Foundation. 2017. *The GNU Privacy Guard Manual.* Cambridge, MA: Free Software Foundation.. Read in Emacs with `M-x info-display-manual RET gnupg RET`.

The Email Self-Defense web site has a very good introduction to GnuPG.

UNFINISHED *Emacs Speaks Statistics: Data Analysis*

UNFINISHED *Maps*

UNFINISHED *Chat*

Internet Relay Chat (IRC)

Jabber

UNFINISHED *Emacs as Window Manager*

Games and Amusements

Emacs comes with 24 built-in games and amusements, and there are at least 43 more in the Package Manager. If any of the games I mention aren't available in your Emacs, just search them in the Package Manager. I've divided them into several categories.

Actual Games

By this I mean games with a computer opponent that you play against, or classic computer games in which you try to get a better score than the last time. The only true built-in games with a computer opponent are `M-x gomoku`, which plays Gomoku or Five-in-a-Row, `M-x chess`, and `M-x gnugo` which is a front-end to the GNU Go engine (which you'll have to install via your OS package manager).

`chess` has a very weak game engine implemented in Emacs Lisp so you can play it right away, but if you install any of several strong chess engines via your OS package manager, like `gnuchess` or `stockfish`, `M-x chess` will detect it and you can play against a much stronger opponent. The default chessboard is a simple ASCII representation, but you can install optional graphics for a more traditional look; see the documentation. `M-x chess-ics` lets you play against human opponents elsewhere on the Internet via an Internet Chess Server.

In the computer-game category we have `M-x dunnet`, a text adventure in the mold of the classic Advent a.k.a. Colossal Cave Adventure[430]. Dunnet is almost unique among all Emacs programs of any kind in that it can be run in batch mode, from a terminal outside of Emacs![431] We also have `tetris`, `snake`, and `pong`—just `M-x` any of them. You can also install Pac-Man from the Package Manager under the name `pacmacs`.

[430] People slightly less old than I am might say, "in the mold of Zork".

[431] Just invoke: `emacs --batch -f dunnet`; *why* you would do this instead of play it inside Emacs is beyond me.

Puzzles

There are a number of puzzles or solitaires. One of the best is Boruch Baum's `crossword` puzzle. It downloads free puzzles from various sources (e.g. *The Washington Post*) which you can attempt to solve

(hints are available). The user interface for this puzzle is really well done, but if your puzzle grid isn't perfectly square, I suggest abandoning your game, adding this to your Init File and restarting (the issue revolves around your default font and how good its Unicode coverage is):

```
(setq crossword-empty-position-char "#")
```

`M-x blackbox` plays Eric Solomon's famous Black Box game (as a "game" it's really a competitive solitaire). `M-x solitaire` plays Peg Solitaire, `M-x bubbles` is an implementation of Same Game, and `M-x 5x5` is a puzzle with several different automatic solvers which you can watch (which may put this in the category of Display Hacks). Finally `M-x mpuz` is a multiplication puzzle.

Cryptography

There are several commands related to traditional cryptography[432]. Emacs supports ROT13, the traditional Caesar cipher of Usenet, still occasionally used as it was then to obfuscate punch lines. `M-x rot13-region` and friends will encode or decode ROT13, since it's its own inverse.

[432] Non-digital; for the real thing, see *EasyPG Assistant*.

> Two conspiracy theorists walk into a bar. Lbh pna'g gryy zr gung jnf whfg n pbvapvqrapr…

Then there's the very impressive `M-x decipher-mode`, which provides assistance in decrypting monoalphabetic substitution ciphers. Insert your ciphertext in a new Buffer and invoke `M-x decipher`, which will set the Buffer up and invoke the Mode. Special commands will list letter and digram frequencies, show adjacency lists, and the like.

Of course Emacs can handle Morse code:[433] just set the Region around this message and invoke `M-x unmorse-region`; encode your own messages with `M-x morse-region`.

[433] Can't your editor?

```
.--/..../.-/- ..../.-/-/.... --./---/-.. .--/.-./---/../--./..../-
```

Display Hacks

There are a number of amusements that fall into the category of *display hacks* (i.e. fun things to stare at). `M-x hanoi` implements the Towers of Hanoi puzzle, well-known to programmers for its simple recursive solution.

Infinitely more interesting is `M-x life`, an implementation of Conway's famous cellular automaton. One of 17 starting patterns is randomly chosen. It's not hard to add your own, but check out the Life

Lexicon for everything you could possibly want to know about patterns, and additional Elisp code.

Emacs also has its own screensaver. Just say `M-x zone` and your Emacs will zone-out randomly. It's hard to describe, but either something disturbing but very subtle will happen, or something *very* disturbing and extremely in-your-face will. Regardless of how messed up your precious text looks, I assure you that nothing is really happening. Give any Emacs command at all, and the zoning will stop and all apparent destruction will vanish. Definitely one of the best things in Emacs.

Jokes / Wackiness

Finally we have a motley assortment of oddities. I mentioned at the very beginning that Emacs comes with a Rogerian therapist; you might need one after watching `M-x zone`. Just invoke `M-x doctor` if you feel the need to talk things out; it's an Elisp implementation of Weizenbaum's famous ELIZA program from the MIT AI Lab in 1966: more of an early Natural Language Processing project than a psychology one, ELIZA was the first chatbot.

Unix systems have had a *fortune cookie* program since 1979, which prints a random quip, quotation, or joke every time it's run. `M-x fortune` does the same thing for Emacs[434].

In honor of several XKCD comics on the topic of Emacs, we have the otherwise inexplicable `M-x butterfly` (you'll have to bind it to `C-x M-c M-butterfly` yourself).

References

Poundstone, William. 1985. *The Recursive Universe: Cosmic Complexity and the Limits of Scientific Knowledge.* Chicago: Contemporary Books..

[434] It's not a front-end to `fortune(6)` but rather accesses the fortune data files directly.

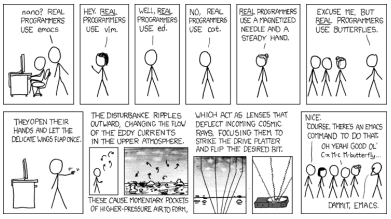

Figure 61: Real Programmers

Part IV

EMACS FOR...

UNFINISHED *Emacs for Writers*

> Writing should be all about the words. But word processors like Microsoft Word, Google Docs, or Apple's Pages force you to think about formatting as you compose. — Ashton Wiersdorf

Emacs is heavily used for authoring printed documents (memos, journal articles, books like this one), and online documents like PDFs and HTML pages (and entire web sites). You'll remember that "the one thing Emacs isn't" is a WYSIWYG word processor like Microsoft Word or Google Docs: instead, Emacs authors use a *markup language* of some kind that's "typeset" by an external program: the most popular must surely be LaTeX, and nowadays the flexible Org Mode must be a close second. See *Typesetting and Publishing* below for these.

The rest of this chapter describes facilities and subsystems that can assist across many different authoring modes.

Text Mode

`text-mode` is one of the oldest of all the Emacs major modes. It's rarely used these days; most people use Org Mode instead, or else a text-formatting markup language like LaTeX. `text-mode` is for editing plain, unspecialized, natural language prose, i.e. blank-line separated paragraphs consisting of sentences.

If you prefer your paragraphs to be recognized by leading indentation of the first line, so that you don't need blank lines between them, you should use `M-x paragraph-indent-text-mode` instead of `text-mode`. There's an equivalent Minor Mode, `paragraph-indent-minor-mode` that you can use in other texty Major Modes (like, say, `message-mode` for emails.

If you really want to use it, there's not much to say about `text-mode`. You can Customize the `paragraphs` group with `M-x customize-group` to fine-tune the details of how paragraphs and sentences are handled, but that's about all I can think of.

Outline Mode

Emacs has had the Major Mode `outline-mode` since the very beginning. It uses a very simple markup to structure text into an outline, and provides three main features:

- folding text i.e. hiding and revealing branches of the outline to make it easier to see the document structure, and to focus on one part at a time
- colorful syntax highlighting that makes it easier to spot the headlines (headings)
- commands to navigate by headlines, and to easily move headlines—and everything underneath them recursively—around: promote and demote them, and rearrange siblings amongst themselves.

However, `outline-mode` has for some time been eclipsed by its compatible but much more powerful sibling, Org Mode. While Org is enormous and daunting in its power, at the level of simple outlining, it's actually *easier* to learn and use than `outline-mode`; I can't see any reason for anyone not to skip directly to Org Mode. Org is great for writers, especially given its built-in abilities to export directly to beautifully typeset documents in the form of PDFs, HTML, and more.

Wrapping Lines and Filling Paragraphs

The Minor Mode `auto-fill-mode` breaks lines between words for you automatically as you're typing, whenever the length of the line exceeds the value of the Buffer Local variable `fill-column`. To *break* the line means to insert a newline; when `auto-fill-mode` is on, this happens whenever you type a space and the line is about to get too long. When enabled, you'll see the lighter "Fill" in the mode line.

The default value of `fill-column` is 70 characters. You can change that default via Customize, or in your Init File with `setq-default`, or via a File-Local Variable. You can also change it locally in the current Buffer with `M-x set-variable`, but the easiest way is to use `C-x f` (`set-fill-column`).

`auto-fill-mode` is by default *adaptive*, which means it tries to propagate a common prefix to all the lines of your current paragraph. Whitespace indentation is always propagated, so you start a paragraph with two spaces, for example, all subsequent auto-filled lines will be similarly indented. You can also set an explicit fill-prefix with `C-x .` (`set-fill-prefix`). Many programming languages, like Python, start comment lines with #. So if you want to write a big

block comment in `python-mode`, start the first line, position Point after the `#` (and any spacing after it you want to include), and hit `C-x .`, which take all the characters from the beginning of the line up to Point as the prefix. Now all subsequent auto-filled lines will be commented automatically. (Note that almost all Major Modes for programming languages will have their own way of automating the entry of block comments, so you won't typically have to do this. But you might want something similar in plain text.)

I guess if you prefer to hit `RET` explicitly rather than letting Emacs fill your lines for you, then you might appreciate a visual indication of the fill column: turn on the Minor Mode `display-fill-column-indicator-mode`; it will draw a vertical line down your Window at the fill column.

When you're typesetting via some markup language, the program processing your text probably doesn't care about the lengths of your lines or the regularity of your paragraphs—it's going to wrap your lines and fill your paragraphs for you *in the typeset output*. But many people are happier editing text whose lines don't have erratic lengths and whose paragraphs are filled at about the same margin. I enable `auto-fill-mode` in `text-mode-hook` like so:

```
(add-hook 'text-mode-hook 'auto-fill-mode)
```

Since Org Mode, the Mode I use for all my publications (and all my notes), inherits from `text-mode`, I get auto-fill in Org Mode too.

Filling Paragraphs

`auto-fill-mode` only fills one line at a time, as you're typing it; it doesn't re-fill your paragraph after you've deleted a bunch of text from the middle of it, rendering the paragraph all ragged. Most people do that explicitly, as needed, with `M-q` (`fill-paragraph`), which completely re-fills the current paragraph with a ragged-right, or all the paragraphs in the Region if it's activated. With a Prefix argument, `M-q` will fill *and right-justify*. `M-q` respects the fill column and the fill prefix as well.

I said `auto-fill-mode` doesn't re-fill your paragraphs as you edit them the way a word processor does, but the Minor Mode `refill-mode` does. I actually never even heard of this one until just now.

The command `M-x fill-region-as-paragraph` will convert multiple paragraphs into one, by deleting paragraph separators and then refilling the whole region.

All these filling commands support a lot of customization; see "Filling" in the *Emacs* manual for details, and the Customization group `fill`.

Breakable and Non-breakable Spaces

Occasionally you'll find a spot between two words where you really don't want `M-q` to break the line. In this case, if you use the Unicode character NO-BREAK SPACE instead of an ordinary space; `M-q` won't break the line there. You can insert one with `C-x 8 SPC`; see *Inserting the Occasional Funny Character* for details.

Spell Check

Unless you're an ex-spelling bee champion, you'll want to have spellcheck enabled for your text Modes. The built-in spell-checking tools are Ispell and `flyspell-mode`. Ispell is a collection of commands that communicate with the old Unix `ispell(1)` program (which dates back to 1971); while I use a few of its commands occasionally, its interface is somewhat old-fashioned and a little tedious to use. Instead I use Flyspell, which provides a faster interface to `ispell(1)`.

Spellcheck is handled by an external program, which you'll need to have installed, either the venerable `ispell(1)` or one of its compatible descendents, `aspell(1)`, `hunspell(1)`, or `enchant(1)`. Check to see if you're ready to go by running `M-x ispell-check-version`; if all is well, it will print a messages like:

```
@(#) International Ispell Version 3.1.20 (but really Aspell 0.60.8.1)
```

If you get an error, you have to have your OS package manager install one of these programs.

But which program? You should prefer either `aspell(1)` or `hunspell(1)` over `ispell(1)`, because they support UTF-8 and dictionaries for multiple languages without the extra configuration `ispell(1)` requires; they both provide more accurate corrections too. In fact, if `ispell(1)` is what's detected by `ispell-check-version`, I would recommend installing one of the other ones anyway (Emacs will prefer either of them even if `ispell(1)` is installed). I use `aspell(1)` myself, because when I last used `hunspell(1)` it didn't deal with contractions very well, and I've never tried `enchant(1)`. If you want to make sure Emacs uses your choice of spellchecker, Customize `ispell-program-name`.

Now let's get spellchecking. You probably want spellcheck in all Major Modes derived from `text-mode`, so do `M-x customize-variable text-mode-hook` and enable Flyspell; now it'll work in Org Mode and most everyplace else where you're writing. If you're a programmer, you might also Customize `prog-mode-hook` and enable `flyspell-prog-mode`, which will then do spellchecking in your programming language Modes, but only within comments and string

literals. Of course you can also toggle it on and off manually in any Buffer with `M-x flyspell-mode`.

Flyspell Mode

Table 73: Flyspell Commands

Key	Action
`C-.`	correct the current word
`C-c $`	... via a popup menu
`C-;`	correct the previous misspelled word
`C-,`	move to the next misspelled word
`M-$`	add a new word to your personal dictionary

Flyspell is very easy to use. When enabled, it highlights suspected misspellings, as you type, with wavy red underlines. If you immediately notice the misspelling and want to correct it, type `C-.` (`flyspell-auto-correct-word`),[435] and it will replace the misspelling with the first of several possible corrections. If that's not the one you wanted, hit `C-.` again to change to the next one. You can very quickly whip through half-a-dozen with `C-.`; if you overshoot in haste, just Undo. All the suggestions are shown, in the order they'll be offered, in the Echo Area. `C-c $` (`flyspell-correct-word`) does the same correcting via a popup-menu at Point.

[435] That's control-period...

`C-;` (`flyspell-auto-correct-previous-word`) is the long-distance version of `C-.`: it corrects the nearest misspelled word before Point, even if it's many words back. When you're typing at speed, you'll often have typed several words before the red squiggles catch your eye; `C-;` let's you correct that word without moving Point. Like `C-.`, hit `C-;` repeatedly to cycle through the corrections.

I find `C-;` can be a little bit dangerous; if you hit it by accident and aren't paying attention, you can find out (sometimes much later) that you accidentally corrected a valid word to what is now the incorrect word. I don't disable this command—it's too useful—but you might keep it in mind.[436]

[436] Thank goodness for `C-x v =` (`vc-diff`)...

Of course it's possible none of the suggested corrections are what you want; if you want a correction that's not listed, just do it manually with a quick `M-DEL` (`backward-kill-word`) and type in the correct word.

If the word you typed is correct but not known to Flyspell, you have two choices: just leave it there and ignore the red squiggles forever, or teach Flyspell[437] this new word. `M-$` (`ispell-word`) followed by `i` will add the word preceding or containing Point to your personal dictionary (see below). If the word just happens to be capitalized, you probably want to add the lowercase version of the word to your dictionary for greater utility; use `M-$ u` instead. Of course, if

[437] Actually Ispell, which is what Flyspell is talking to.

the capitalized form is the only correct spelling, then that's what you should add.

You can move through your misspellings ahead of Point (or, with a Prefix Arg, prior to Point) with `C-,` (`flyspell-goto-next-error`).[438]

[438] That's control-comma...

One thing to keep in mind is that Flyspell only marks misspellings *as you type them*. So, if you Visit a file that has misspellings, and immediately hit `C-,` to jump to the first error, Flyspell will just say "no more misspelled words" (because you haven't typed any misspelled words yet). If you want to spellcheck the whole Buffer, you need to run `M-x flyspell-buffer` first; then all your misspellings will be squiggled-up and you can step through them all with `C-,` to fix them. You can instead use `M-x flyspell-region` to check a smaller portion of the buffer. But see below.

Flyspell binds `C-M-i` to `flyspell-auto-correct-word`, which it also binds to `C-.`. This makes me very unhappy; I think `C-.` is much easier to type, and `C-M-i` is a common binding in many Major Modes, so Flyspell ends up stealing whatever command is on `C-M-i`. I disable that in my Init File like so:

```
(with-eval-after-load 'flyspell
  (define-key flyspell-mode-map (kbd "<M-tab>") nil)
  (define-key flyspell-mode-map (kbd "C-M-i") nil))
```

Ispell Commands

While Flyspell does most of what I need, there are a couple of Ispell commands that I also use occasionally.

`M-x ispell-buffer` and `M-x ispell-region` are useful for mass-spellchecking a Buffer. Ispell has been in Emacs for a very long time and has a somewhat old-fashioned user interface. In particular, it's more *modal* than most Emacs interfaces, rather like a Query Replace: once you start, the intention is for you to finish spellchecking in one go (though it supports Recursive Edit and you can easily quit and start over where you left off).

The spellcheck starts with the first misspelling in the Buffer (or Region), and pops up a window offering possible corrections, each numbered (I'll call these numbers *replacement codes*). Typing one of the numbers makes that correction and Ispell proceeds to the next misspelling. If there are more than ten suggestions, letters and punctuation will also be used to identify them. You hit `SPC` to accept the supposed misspelling as correct.

This is simple enough, and even though you might have to eyeball a dozen or more suggestions to identify the right replacement code, it's quicker than cycling through Flyspell's `C-.` a half-dozen times for each word.

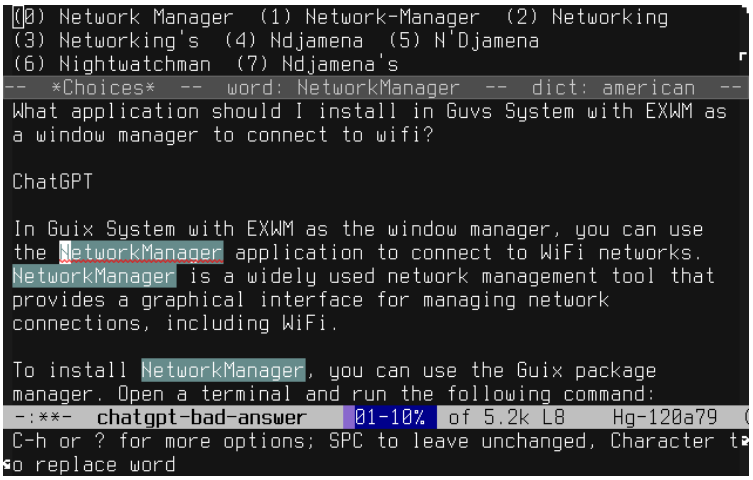

Figure 62: Ispell in Action

But it's the additional keystrokes that are available that really make Ispell faster at spellchecking an entire Buffer. Table 74 lists the options; here *word* means the possible misspelling in the Buffer, and *suggestion* means one of the numbered candidates.

Key	Type	Action
`0..9`	Correct	replace the word with the suggestion labeled `0..9` etc
`r`		Replace word with a typed-in replacement and recheck
`R`		Replace word with a typed-in replacement and `query-replace` in buffer
`l`		Look up a typed-in replacement in dictionary with wildcards
`SPC`	Accept	accept word this time
`i`		accept word and Insert it in your personal dictionary
`u`		same but Un-case word first (insert lowercase version)
`a`		Accept word as correct for the rest of this Ispell session
`A`		Accept word as correct but only for this buffer / file
`x`	Stop	eXit spellcheck, restoring Point
`X`		eXit spellcheck, leaves point here, restart later from here
`q`		Quit spellcheck and kill `ispell(1)` process
`C-r`		enter Recursive edit
`C-l`	Display	redraw screen
`?`		show help for these commands

Table 74: Ispell Misspelling Correction Options

When you're actually correcting a misspelling, the main alternative to typing a replacement code is `r`, which lets you type in an ad hoc correction. After you type it, Ispell will recheck your new word to make sure it's what you intended. You can also use `R` to change all occurrences of the word in the Buffer to your typed-in replacement.

When instead you're refusing all suggestions because the word is correct, you can use `SPC` to accept it just this once—if the word recurs later in the Buffer, Ispell will ask about it again. But more often you'll want to accept it for the remainder of the spellcheck and have Ispell

skip over all the recurrences; this is the `a` command. Perhaps even more often than that, you'll want to use the `i` command and add the word to your personal dictionary so that it's considered a valid word from now in, in all future Ispell sessions. The `u` command is like `i`, but *un-cases* the word (i.e. lowercases it) when it adds it your dictionary.

You can abort this Ispell session with `X`; if you then restart with another `M-x ispell-buffer`, Ispell will pick up where you left off.

Third-Party Spellcheckers

There are more recent third-party spellcheck packages available, which are mostly about speed. Flyspell works well for me; the way I use it, it's perfectly responsive, even for the 200,000-word file that makes up this book. But I admit I never use `M-x flyspell-buffer` to spellcheck my whole book in one go—that is indeed pretty slow on this book—I just rely on Flyspell to report spelling errors as I type and it works fine that way. If you need something faster, check out the third-party packages `jinx`, `jit-spell`, and `spell-fu` via `C-h P` (`describe-package`).

There are also twenty-odd additional packages that implement different interfaces, completion front-ends, and the like for various of these spellcheckers.

Dictionaries and Thesauri

A dictionary and a thesaurus must be two of the most important tools for any writer. There's no shortage of dictionary web sites out there, but some of them require you to create an account (which usually means more spam for you), some deliver ads, many are cobbled together from unspecified sources, and I'm sure there are already awful dictionaries generated by AI. Regardless, we'd prefer to have a dictionary that's nicely integrated into Emacs.

The built-in Emacs Dictionary searches multiple dictionaries at a time and quickly pops up definitions with pronunciation, parts of speech, brief etymologies, representative quotes, and usage hints.

One of the dictionaries is the 1913 edition of *Webster's Revised Unabridged Dictionary*. While this is obviously not the most up-to-date dictionary, it is highly regarded as one of the best dictionaries of American English ever published; see Somers for a discussion. Other dictionaries searched include the more up-to-date Princeton WordNet, the Jargon File, several specialized dictionaries, and a variety of foreign language translating dictionaries.

The main entry point to the dictionary is `M-x dictionary-search`;

I use this all day long, so I highly recommend defining your own key binding for it. This command prompts you for a word; the default is the word at Point. Here's what you'll see for the word "treatise":

```
2 definitions found

From The Collaborative International Dictionary of English v.0.48
   [gcide]:

Treatise "tise\, n. [OE. tretis, OF. treitis, traitis, well
      made. See Treat.]
      1. A written composition on a particular subject, in which
            its principles are discussed or explained; a tract.
            –Chaucer.
            [1913 Webster]

            He published a treatise in which he maintained that
            a marriage between a member of the Church of England
            and a dissenter was a nullity. –Macaulay.
            [1913 Webster]

      Note: A treatise implies more form and method than an essay,
        but may fall short of the fullness and completeness of
        a systematic exposition.
        [1913 Webster]

      2. Story; discourse. [R.] –Shak.
            [1913 Webster]

From WordNet (r) 3.0 (2006) [wn]:

treatise
          n 1: a formal exposition
```

Try searching for "window", "buffer", "megabucks", "oxygen", "syracuse", "suriname", and "imho" to see examples with results from the specialized dictionaries.

One of the dictionaries is the Moby Thesaurus[439], but see below for more on that.

[439] Try searching "moby"...

The dictionaries are all hosted at `dict.org`, so the Emacs Dictionary only works when you have internet connectivity. All the dictionaries are freely available for download, so you can in fact run your own dictionary server on your laptop or local network, but I think very few people bother with this (I don't). By default, the dictionary will assume you're running your own server; I recommend this Customization for your Init File to avoid an initial warning.

Init File

```
(setq dictionary-server "dict.org")     ; we don't run our own server
```

The Dictionary Buffer

The result of your search comes up in a Dictionary Buffer, which has a header with four clickable buttons:

```
[Back] [Search definition]         [Matching words]        [Quit]
       [Select dictionary]         [Select match strategy]
```

There is also a set of key bindings.

Table 75: `*Dictionary*` Buffer Bindings

key	Button	Action
`s`	`[Search definition]`	Search for a new word
`d`		display Definition for the word at point
`l`	`[Back]`	go back (Left) in word history
`m`	`[Matching words]`	list all words Matching pattern.
`D`	`[Select dictionary]`	select the default Dictionary
`M`	`[Select match strategy]`	select the default Matching Strategy
`n`, `TAB`		move to the Next link
`p`, `S-TAB`		move to the Previous link
`RET`		follow link at point
`q`	`[Quit]`	close the dictionary buffer
`h`		display this help information

Matching Words

In addition to looking up word *definitions*, you can also look up words themselves with `M-x dictionary-match-words`. In its default mode, this can be useful for looking up a word that you don't know how to spell, since it returns a list "similar" words[440] But in the Dictionary Buffer, you can change strategies with the `[Select match strategy]` button; if you choose "Match prefixes" for example, then searching for "ambi" will list 72 matches, including Ambidextrous, Ambient, Ambiguous, and Ambitious.

[440] Using the same Levenshtein-distance algorithm that a spell checker uses.

The Available Dictionaries

There are 15 basic dictionaries (see Table **??**) you can choose from with the `[Select dictionary]` button; the default is to search all of them, but if you choose a specific one, your choice will persist as long as you do searches in this Dictionary Buffer.

Translation Dictionaries

There are also 148 dictionaries that will translate between various pairs of languages like French, Bulgarian, Kurdish, Slovak, Swedish, Lateinisch, Modern Greek, Italian, Latin, and Swahili, for example.

Table 76: Available English Dictionaries

gcide	The Collaborative International Dictionary of English v.0.48
wn	WordNet (r) 3.0 (2006)
moby-thesaurus	Moby Thesaurus II by Grady Ward, 1.0
elements	The Elements (07Nov00)
vera	V.E.R.A. – Virtual Entity of Relevant Acronyms (February 2016)
jargon	The Jargon File (version 4.4.7, 29 Dec 2003)
foldoc	The Free On-line Dictionary of Computing (30 December 2018)
easton	Easton's 1897 Bible Dictionary
hitchcock	Hitchcock's Bible Names Dictionary (late 1800's)
bouvier	Bouvier's Law Dictionary, Revised 6th Ed (1856)
devil	Ambrose Bierce's *The Devil's Dictionary* (1881-1906)
world02	CIA World Factbook 2002
gaz2k-counties	U.S. Gazetteer Counties (2000)
gaz2k-places	U.S. Gazetteer Places (2000)
gaz2k-zips	U.S. Gazetteer Zip Code Tabulation Areas (2000)

Just select the proper dictionary, say English-German, and search "dictionary" to get "Lexikon", "Verzeichnis", amd "Wörterbuch".

Thesauri

> Thesaurus *sau"rus\, n.; pl. Thesauri. [L. See Treasure.]
>
> A treasury or storehouse; hence, a repository, especially of knowledge; – often applied to a comprehensive work, like a dictionary or cyclopedia.
>
> [1913 Webster]

As mentioned above, the Dictionary includes the Moby Thesaurus, a substantial project with 30,000 headwords and more than 2.5 million synonyms and related terms. Each of your Dictionary searches will include results from this thesaurus. For example, a search for "radiating" results in:

> 20 Moby Thesaurus words for "radiating":
>
> approaching, asymptotic, centripetal, centrolineal, concurrent, confluent, confocal, connivent, converging, focal, meeting, mutually approaching, radial, radiate, radiated, radiative, rayed, tangent, tangential, uniting

While I find this pretty useful, the problem with this resource is that it's just a pile of undistinguished words. In fact I chose "radiating" because many words result in an overwhelming *hundreds* of synonyms! My preferred thesaurus is the third party package `mw-thesaurus`, which, for "radiating" for example, clearly distinguishes between the senses "to extend outwards from or as if from a central point", "to emit rays of light", and "to throw or give off", and classifies the results as Synonyms, Related words, Near antonyms, and Antonyms.

More Third-Party Options

There are several other third-party dictionary and thesaurus packages available. Some candidates (not tried by me) include:

define-word display the definition of word at point

le-thesaurus Query thesaurus.com for synonyms of a given word

lexic A major mode to find out more about words

powerthesaurus Powerthesaurus integration

synonymous A thesaurus at your fingertips

wordnut Major mode interface to WordNet

wordreference Interface for wordreference.com

References

- Raymond, Eric S. and Guy L. Steele. 1996. *The New Hacker's Dictionary, 3rd edition.* Cambridge, MA: MIT Press. `http://www.catb.org/~esr/jargon/`.

- Somers, James. 2014 May 18. *You're Probably Using the Wrong Dictionary.* `https://jsomers.net/blog/dictionary`.

- Steele, Guy L., Jr., Richard M. Stallman, Mark R. Crispin, Raphael A. Finkel, Donald R. Woods and Geoffrey S. Goodfellow. 1983. *The Hacker's Dictionary: A Guide to the World of Computer Wizards.* New York: Harper & Row. `http://www.catb.org/~esr/jargon/`.

- Emacs Dictionary documentation

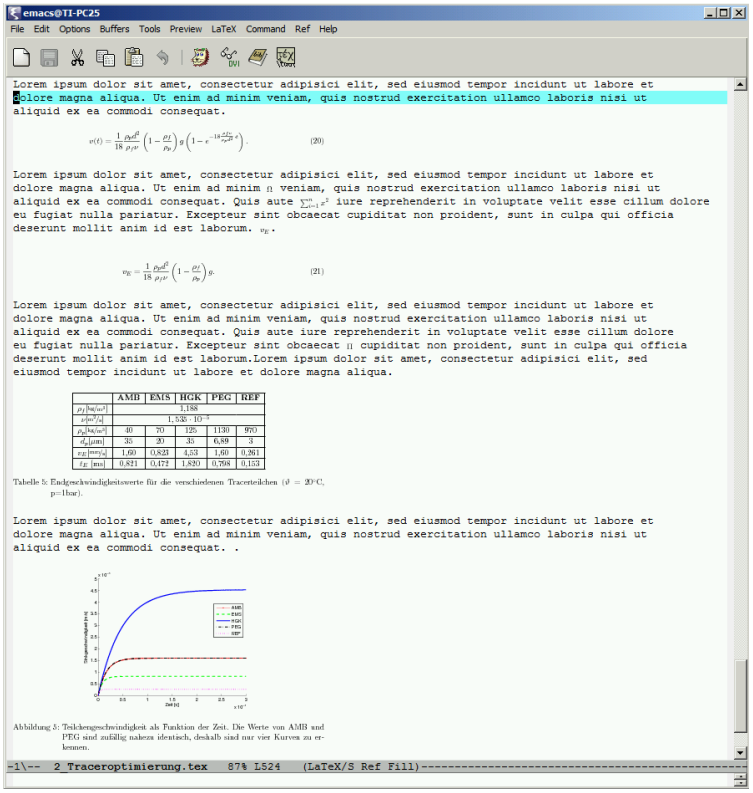

Figure 63: Editing a Document with AUCTeX

UNFINISHED *Presentation Slide Shows*

UNFINISHED *Generating Web Pages and Web Sites*

UNFINISHED *Typesetting and Publishing*

TEX and LATEX

Texinfo

Fountain Mode for Screenplays

Groff

Org

Muse

UNFINISHED *Footnote Minor Mode*

UNFINISHED *Managing Bibliographic Citations*

UNFINISHED *Typing Tutors*

UNFINISHED *Emacs for Programmers*

UNFINISHED *Compiling Code*

UNFINISHED *Managing Projects*

UNFINISHED *Tags and The Xref Subsystem*

Imenu

UNFINISHED *Commenting and Uncommenting*

UNFINISHED *Change Logs*

"Change Log" in the *Emacs* manual.

UNFINISHED *On-the-Fly Syntax Checking*

UNFINISHED *Debugger Support*

UNFINISHED *Emacs for Emacs Lisp Programmers*

UNFINISHED *ERT: Emacs Lisp Regression Testing*

UNFINISHED *The Elisp Debuggers*

Part V

THE BACK OF THE BOOK

Appendices

Varieties of Emacs: A History

"Emacs"[441] is actually the name of a family of text editors that are either descended from or inspired by one another. The original Emacs was written at the MIT AI Lab in 1976 by famous Lisp hackers Dave Moon and Guy L. Steele Jr. It was implemented in the famously cryptic[442] command language of the command-line text editor TECO to provide it (TECO, that is) with a collection of useful macros and an enhanced visual mode. This Emacs ran on a DEC PDP-6 under the Incompatible Timesharing System (ITS), and would be completely recognizable to a modern Emacs user.

For an editor to deserve the name "emacs" the main requirement is that it be fully extensible with a real programming language, just like original TECO Emacs. For GNU Emacs, this language is Lisp. Other Emacsen have used Lisp and Scheme, a dialect of Trac called Mint, interpreted C-like languages, etc.

TECO, and thus the original Emacs, was implemented in PDP-6 assembly language, and so wasn't readily portable to other computer architectures (except perhaps the related PDP-10). But seemingly everyone who'd ever used Emacs insisted on having it, so many completely new reimplementations were created. The first new version, by Dan Weinreb, was also the first Emacs implemented in Lisp, for the MIT Lisp Machine. This was EINE, which stood for "EINE Is Not Emacs" (which was probably the second recursive acronym).

In 1978, Bernie Greenberg implemented Multics Emacs for the Honeywell 6180 running the Multics operating system; this Emacs was implemented in Maclisp. At the same time a new version for the Lisp Machine was released, the wonderfully-named ZWEI ("ZWEI Was EINE, Initially"). From this point on, there was a specially-built Emacs or Emacs-alike of some sort for many other machines and operating systems (e.g., SunOS, VMS, MS-DOS, CP/M, etc).

The software portability enabled by the Unix operating system and the C programming language, and the gradual dominance of Unix, finally somewhat tamped down the fecund growth of this Emacs

Figure 64: David A. Moon

[441] "Editing MACroS"

[442] But Turing-complete.

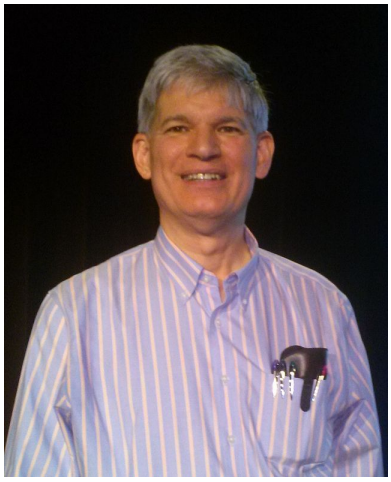

Figure 65: Guy L. Steele (gls)

ecosystem.

The first Emacs for Unix was Gosling Emacs (a.k.a. *Gosmacs*), implemented by James Gosling in 1981. It was written in portable C, but its extension language, Mocklisp, was only superficially similar to Lisp and couldn't be considered a serious programming language.

Gosmacs was initially freely redistributable, but went commercial in 1983 as Unipress Emacs.

GNU Emacs, released in 1985, was written (also in C) by Richard Stallman, arch hacker and Chief GNUisance, an early contributor to and maintainer of the original TECO Emacs. He started with the freely-redistributable code of Gosmacs, but replaced Mocklisp with a true Lisp interpreter (implemented in C), changing virtually all the Gosmacs code in doing so. Unipress complained about the remainder of the original Gosmacs code in the freely-redistributable GNU Emacs, and within a few months, Stallman had replaced it all with his own original code.

Figure 66: Richard M. Stallman (rms)

As microcomputers encroached on the province of time-shared mainframes and minicomputers in the 1980s, microcomputer Emacsen began to appear. Due to memory limitations, most of these were not the real thing and had sub-standard, if any, extension languages. Still, they were way better than `edlin`. Notable examples, among many others, include MINCE[443] (1981), which ran on 8-bit Z80's running CP/M; JOVE (1983); MicroEmacs (1985); mg (1986); and probably the closest of them all to a true Emacs, Russ Nelson's Freemacs (1986), a 21K MS-DOS executable with a real extension language, MINT ("MINT Is Not TRAC"). Freemacs was written in a combination of 304,470 bytes of 8086 assembly language and a whopping 294,976 bytes of MINT.

[443] "MINCE Is Not Complete Emacs".

These early Emacsen were all non-graphical text-mode applications. In 1989, work was begun at the University of Illinois on a graphical-mode *fork* of GNU Emacs for the X Window System, called Epoch. Lucid, Inc. needed more than Epoch provided and started their own fork, originally called Lucid Emacs but better known as XEmacs. The graphical features were intended to be merged into GNU Emacs, but there was disagreement on the implementation issues, and the XEmacs fork became more of a schism: XEmacs was permanently divorced from GNU Emacs; the two projects coexisted (and shared code) for close to twenty years. XEmacs development ceased in 2009.

Nowadays, most other Emacsen are variants or forks of GNU Emacs, like the GNU version for Microsoft Windows, or Aquamacs, a version for Mac OS that uses the native Cocoa API. Today, GNU Emacs effectively *is* Emacs.

Historical Firsts & Innovations

GNU Emacs may well be the longest-lived (39 years old) free software computer program (excluding operating systems) still in active development. It's an important part of the history of computing, not least because of the many innovations that debuted in Emacs, many of which have gone on to be standard features that are now expected to be present in any editor or IDE.

There's a hobby called *retrocomputing* where enthusiasts resurrect, preserve, and use ancient computer hardware and software. As of this writing, Gen Z'ers in droves are supposedly trading in their smart phones for old-school flip phones.[444]

[444] Albeit probably less as a hobby and more because of the stress induced by social media.

Emacs is possibly unique in providing the fun of retrocomputing in a completely modern, up-to-date, actively evolving, and completely usable system.

Here's a partial timeline of Emacs firsts. It can be hard to pin down the facts on some of these; any mistakes are entirely my own.

1976 ITS Emacs created.

1976 real-time display (full-screen) editor "In the early to mid-1970s, [Richard] Stallman would make some key enhancements to TECO that allowed it to become a fully interactive, WYSIWYG-style onscreen editor." — Dan Murphy, *The Beginnings of TECO*

1976 docstrings The concept of actually attaching the documentation of a function to the function itself was invented in ITS Emacs and enabled the online help system.

1976 hypertext Emacs's Info was one of the first freely available hypertext systems, predating the World Wide Web by about fourteen years.

1976 file manager Dired was one of the earliest file managers, and probably the first to be built-in to an editor.

1978 incremental search Invented in ITS Emacs.

1985 GNU Emacs released.

1985 completion GNU Emacs was probably the first editor with completion, and possibly the first non-shell (completion was invented in the TENEX "shell" in 1969, and then adopted in `tcsh(1)` in 1981).

1985 undo The first editor with unlimited undo and redo.

1985 IDE Arguably the first all-software, multi-programming-language IDE.

1989 transparent remote file editing Via the `ange-ftp` package, now subsumed by Tramp.

1992 file local variables Stems from Elisp's unusual variety of scopes.

1992 Incremental Narrowing Framework I believe Icomplete was the first INF.

Emacs vs. The Unix Philosophy

Emacs has often been criticized by Unix purists as being diametrically opposed to the Unix Philosophy. Unix is supposed to consist of many small, simple commands that each do one thing well, whose power comes from their composabilty via shell pipelines, while Emacs is the ultimate monolithic application: one enormous program that tries to do everything itself.

This is seen as a violation of a key precept of the Philosophy:

> Make each program do one thing well. To do a new job, build afresh rather than complicate old programs by adding new "features". — Doug McIlroy, "UNIX Time-Sharing System"

I would like to suggest that Emacs is actually a *better* manifestation of the Unix Philosophy. The ideal Unix system consists of many small programs written mainly in C, run by the Unix kernel; Emacs consists of many *functions* written mainly in Elisp, any of which will be even smaller than the smallest Unix programs, run by the Lisp kernel.

Ideal Unix programs are composable via pipes: the output of one program can be the input to another. Emacs Lisp functions are inherently composable.

Unix programmers are exhorted to "write programs to handle text streams, because that is a universal interface." Flat text streams are just a stream of bytes with at best a minimal two-dimensional structure of lines of characters; any additional structure has to be imposed on that. But there's no standard for any extra structure, and so every program comes up with something different (colon-separated fields? CSV? XML? JSON?). Even in 1978 McIlroy felt the need to warn the programmer not to "clutter output with extraneous information" and "avoid stringently columnar or binary input formats" in an attempt to mitigate the problem.

Calling an Emacs function is of course *much* lighter-weight than forking and exec'ing even the smallest compiled C program, and all the programs in a pipeline need to parse, unparse (for output) and re-parse each other's flat text data over and over. In contrast, Elisp functions all support the same recursive tree-structured data

format (S-expressions), which doesn't need to be copied or parsed in between the "pipelines" of functions.

Emacs consistently excels at meeting other precepts of the Philosophy:

- "Don't insist on interactive input" (McIlroy). Elisp interactive commands can always be composed with non-interactive functions.
- "Design and build software, even operating systems, to be tried early, ideally within weeks. Don't hesitate to throw away the clumsy parts and rebuild them" (McIlroy). The Emacs user is continually modifying their system as they work.
- "Use tools in preference to unskilled help to lighten a programming task, even if you have to detour to build the tools" (McIlroy). Nothing could be more of an Emacs cliché than devoting time to building and enhancing tools!
- "Self-supporting system: all Unix software is maintained under Unix" (Thompson & Ritchie). Emacs is developed and maintained inside of Emacs, including documentation, debuggers, and packaging.
- "Make it easy to write, test, and run programs" (Thompson & Ritchie). Any Elisp function that throws an error can pop you directly into the ever-present built-in debugger; the profiler and compiler are at your fingertips; the entire state of Emacs at the moment of the error is introspectable; and you can fix the bug and continue your work without so much as restarting.
- "Write abstract programs that generate code instead of writing code by hand" (Raymond). Lisp programming at its most advanced is all about writing Lisp code to generate Lisp code (via macros); see Graham and Hoyte.
- "Write flexible and open programs" (Raymond). Elisp programs are customizable via the Customize Facility, and their behavior can be changed by Buffer Local Variables, dynamic binding, and function advice (see "Advising Functions" in the *Elisp* manual).

A key innovation of Unix was the interactive shell that allowed users to glue programs together interactively, and to easily make new programs out of shell scripts. Emacs is a shell for Elisp functions, without the disadvantages of shell scripts—the difficulties of quoting and the dangers of rescanning commands, weak error handling, poor data structures, poor portability, and inefficient execution due to a lack of compilation.

References

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- McIlroy, M.D., E.N. Pinson and B.A. Tague. July-August 1978. "UNIX Time-Sharing System: Forward." *Bell System Technical Journal* 57, no. 6: 1899-1904. `https://archive.org/details/bstj57-6-1899/page/n1/mode/2up`.

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UNFINISHED *Compilation Mode and its Many Descendants*

The Great Sentence-Ending Controversy

> "Typing two spaces after a period is totally, completely, utterly, and inarguably wrong," Farhad Manjoo wrote in Slate in 2011. "You can have my double space when you pry it from my cold, dead hands," Megan McArdle wrote in the Atlantic the same year. — Avi Selk

The Emacs default of ending sentences with two spaces comes from the era of typewriters: in the monospace font of the typewriter, two spaces made sentence endings easier to see and to distinguish from abbreviations, and so improved readability. In the early days of computing, anything you looked at on a terminal screen or printed from a computer would come out in a monospace font, too.

Nowadays, most of the computer-generated text that we read is digitally typeset and formatted with proportional fonts for a web browser or a PDF viewer. When you generate text like this from Emacs (say, via Org Mode), it doesn't matter at all how many spaces you put after your periods, or even between words: the typesetting process will arrange for an appropriate amount of spacing. So spaces after sentences only affect motion and paragraph filling (also not usually a concern when you're typesetting).

If you're in the habit of using two spaces, like Megan and I, the Emacs sentence commands are ready for you. If you're a one-spacer like Farhad, you can set `sentence-end-double-space` to `nil` in your Init File:

```
(setq sentence-end-double-space nil)
```

but note that the sentence commands will then have to assume abbreviations (e.g. "e.g.") end your sentences, making the commands less useful. Which is why I use two spaces.

If you're a two-spacer, you will find yourself facing a lot of one-spaced sentences as you edit other people's files, emails, and the like. In this situation, `M-x repunctuate-sentences` is a lifesaver: it will convert these sentences to the more useful two-space format.

Install Emacs on ChromeOS

Chrome OS now runs Linux in a VM, and the Emacs you install there is the real thing (though not the latest version). Once you've installed and fired it up, Emacs can be run from the launch bar like any other ChromeOS app.

Installing Emacs on a (post-2018) Chromebook is easy but there are a few steps.

Go to Settings and in the Device tab, click on "Linux (Beta)", then "Turn on".

Click "Install" in the pop-up dialog (the defaults are probably fine).

If after installation completes, a Linux terminal window does not appear, click on the new Unix Prompt (">_") icon in the launch bar (or, if that's missing, fire up the Terminal app from the launcher) and wait for the VM to start up.

At the shell prompt in the VM window, run:

```
sudo apt update
sudo apt upgrade
sudo apt install emacs25
```

Now run Emacs from the shell prompt:

```
emacs
```

With Emacs running, you should see a new icon for it in the launch bar (a script "E"); Alt-click on the icon and select "pin" from the menu. Just to make sure everything's working, exit Emacs (click the "X" in the window's title bar (or use `C-x C-c` (`save-buffers-kill-terminal`)). You can minimize the Linux shell window.

Click the icon to start up a new Emacs. You can start Emacs like this in the future; it will start up the Linux VM if necessary (which makes the first start-up after a reboot pretty slow).

If you have Linux skills, you can fiddle with the package manager to get a more up-to-date version of Emacs.

The biggest problem is not with the Emacs per se; it's that the VM's file system and the Chrome OS file system are mostly separate.

If Chrome is your only machine, no problem (you can backup your data manually via Settings / Linux (Beta)).

But if your Chromebook is just one of several machines, and you want to clone your config from another OS, you'll have to jump through some hoops, either loading it from a web URL, or via Tramp from a host on the network, or synchronize it via `rsync(1)`, `unison(1)`, or the like. Syncing at the file system level is also possible with `syncthing(1)`, `sshfs(1)`, or any of many other tools. The same thing goes for your data.

UNFINISHED *Install Emacs in the Windows System for Linux (WSL)*

The Famous Canards

Many people will argue that you shouldn't use Emacs.

One of the oldest arguments is that Emacs is too big; an old saw goes:

> EMACS: Eight Megabytes And Constantly Swapping[445]

but this dates from days of old when 8M was a *lot* of memory. Nowadays, that's about the size of one pop song in digital form. A modern Emacs takes 26M (52M graphical) of memory; that's a mere 3% of the space my web browser is using at this moment, and in Client / Server usage, this is the only instance of Emacs that will be running on your 8G laptop.

[445] There are many more: "Eventually Munches All Computer Storage", "Emacs Makes A Computer Slow", "Escape-Meta-Alt-Control-Shift", etc, but also "Emacs Makes All Computing Simple".

Another argument is that Emacs takes too long to start up. On my 11-year-old laptop, it starts up in 0.1 seconds (0.5 graphical), which I think is plenty fast enough. If you heavily customize your Emacs and don't take care to make your customizations lazy, you can indeed achieve much slower startup times (perhaps on the order of several seconds — with my 1,120-line Init File it takes 2.4 seconds to start). Since I run the Emacs server, I only pay this cost once, just after I've rebooted; then I can connect to the server, from various terminals and shells, with the Emacs client in less than 0.01 seconds. See Client / Server.

Using the Desktop to persist your buffers across sessions can also slow down your startup time; if this is a problem, Customize `desktop-restore-eager` in order to make the restoration of your Buffers happen *lazily*.

The Troublesome Meta Key

The Meta key is a *modifier key* which works exactly like a Control key or a Shift key in that it generates no character by itself, but rather

modifies another key struck while it's being held down.

What key is the Meta key? On "standard" keyboards, it will be either the Alt key or the Windows key. On Apple keyboards, it will be either the Option key or the Command key. You'll just have to try them and see!

Fire up Emacs with `emacs -Q --no-splash`. Type a word, and then type `Alt-b` using the Alt key. If your cursor moves backwards to the beginning of the word you just typed, Alt is your Meta! If not, try `Windows-b` using the Windows key; this should work, and indicates that Windows is your Meta. Likewise for Command and Option on a Mac keyboard.

If neither of those work, then probably some other program is stealing the Meta key; for example, your X window manager might be using it for its own purposes, in which case Emacs may never see you type it. When this happens, you either have to change Emacs's notion of the meta key, or change the window manager's notion of *its* key.

You can also change which key Emacs uses as Meta for any reason (either necessity or if another key just feels better to you). Whichever key turns out to be your Meta, the *other* key is known as the *Super* key. If your Meta is Alt (Command), your Super is probably the Windows key (Option key). On Unix systems running X11, the Super key is usually used to control your window manager, leaving Meta for Emacs (unless you choose to swap them).

For more help solving Meta key problems, see the Emacs Wiki.[446]

[446] `https://www.emacswiki.org/emacs/MetaKeyProblems`

The `ESC` Prefix

There's one other prefix command that's both very important and completely redundant: the `ESC` prefix. This is the key labeled "esc" on your keyboard; that key lets you type the ASCII Escape (which is a control character: actually it's exactly the same character sent by `C-[`, so you can type that if you prefer).

As described above, not all keyboards provide a suitable Meta key, or it may be reserved or stolen by your desktop or the operating system. If this applies to you, all is not lost. You just use the `ESC` key instead. `M-a` becomes `ESC a`; `C-M-f` becomes `ESC C-f` (remember the equivalence of `C-M-f` and `M-C-f` and this will make sense).[447]

[447] You really don't want to use Emacs without a Meta key, so see *The Troublesome Meta Key* for how to fix this.

There's only one trick: `ESC` is actually an ASCII character, not a shift-like modifier key. If you type Alt, say, without then typing another key simultaneously, nothing happens: Emacs doesn't see that you hit Alt. No key code is sent to Emacs at all. But when you hit `ESC`, you've immediately sent the ASCII Escape character to Emacs. It's just like hitting `Z` or `*`. This means that you don't try to hold

down ESC at the same time as the other key: use it as a prefix character and type it separately and distinctly.

A true Meta is a wonderful thing for Emacs (it makes typing much faster), but I used ESC for years. (When Emacs was born in 1976, hardly any keyboard had any modifier key besides Control and Shift, and everybody used ESC.)

The Least to Know About Public Key Cryptography

Symmetric Encryption

Most encryption techniques use a password or passphrase[448] to encrypt a file that contains a secret. The same password both encrypts and decrypts the file: hence the term *symmetric encryption.*

[448] Which is just a longer, and hence stronger, password.

You have to remember this password if you want to decrypt the file. As long as you're the only person who has to decrypt the file, this isn't too much of a problem, but what if you need to share the file with someone else? Since it's encrypted, you can securely send them the file, say via email, but they can't decrypt it unless you give them the password. But how do you securely send them the password? If you encrypt the password, you have just dug yourself a deeper hole. The only real solution is to arrange a face-to-face meeting, and if you can do that, you might as well just give them the unencrypted secret file while you're at it! This is called the *key-management problem*.

Public-Key Encryption

The real solution to the problem is *Public-Key Encryption*, a.k.a. *asymmetric cryptography*: you use one password to encrypt the file, and a second, different password to decrypt it.

Everyone has a pair of related passwords, or *keys*. One is your *private key* that you zealously keep secret. The other is your *public key* which you share with the entire world: publish it on your web page or social media profile; print it on your business cards; include it in the signature of every email you send; and upload it to a network of key-servers which anyone can query.

Now when you want to send a secret file to someone, you encrypt the file with *their* public key (which you find on their website). Because of the mathematical relationship between each person's public and private key, only the private key can decrypt a secret encrypted with the corresponding public key! So anybody can encrypt a message to person A with A'a public key, but only A can decrypt those messages, with A's own private key. The key management problem is solved!

How do you encrypt a file that only you yourself should see? Simple: just encrypt it with your own public key, and only your own private key (which only you know) can decrypt it.

What if you were to "encrypt" a file with your *private* key? Then only your public key can decrypt it—but that means *anybody* can decrypt it, since your public key is, well, public!

Far from being a disaster, this is actually a bonus: while everyone can decrypt this file, only you could have encrypted it with your private key, so this is a *digital signature*: a secure way of signing a document, like a contract. Once you've signed it, you can't later deny that you'd done so.

With GnuPG you can both securely encrypt files, and securely sign them, or both.

Setting Up Public Key Encryption

Once you've installed GnuPG, you can create your public/private *key pair* by running this command in the shell:

```
gpg --quick-generate-key EMAIL
```

where *EMAIL* is your email address, in the form `test@example.com`.

The private-key part of your key pair is just a huge random number[449], and that number is stored in a file. You'll be asked for a passphrase, which is used to encrypt your private key:[450]; see *On Passwords* for recommendations.

[449] Albeit one with particular properties.

[450] Symmetrically!

In order for GnuPG to compute enough random data to generate your key pair, you should wiggle your mouse, or type any text you like in some other window, or start playing a video[451]. When the command finishes, you'll see something like:

[451] I am not pranking you.

```
public and secret key created and signed.

pub   rsa3072 2023-05-28 [SC] [expires: 2025-05-27]
      5A6256007A1E27CBF51B27D451B2DCA5731D91DE
uid                      test@example.com
sub   rsa3072 2023-05-28 [E]
```

The big hexadecimal number, here `5A6256007A1E27CBF51B27D451B2DCA5731D91DE`, is your *fingerprint*. You can think of it as the id of your public key[452], and you can share it with anyone. Your actual public key is a *really* huge number that will be well over 1,000 hex digits in length. I put my fingerprint in my email signature and on my business cards, and my entire huge public key on my web site.

[452] It's a cryptographically secure hash.

There are many more concepts you'll need to understand in order to use public-key cryptography effectively. See *The GNU Privacy Handbook* for the best explanation.

UNFINISHED *Emacs on Your Phone*

An Initial Init File

Throughout this book I've given a number of recommended snippets for a minimal Init File designed for a beginning Emacs user following along with the text. All these snippets are gathered together in this appendix. You can download them as a usable Init File here:

`https://www2.lib.uchicago.edu/keith/emacs/init.el`

Remember that this Init File is designed in accordance with my notion that you should learn Emacs with as few changes from the defaults as possible. This is definitely not the Init File that I use (mine is 16 times as large)! If you start with this one, you'll slowly change it to suit your needs and preferences and, eventually, will no longer recognize it!

Ask Emacs where to install this file with `C-h v user-emacs-directory`; this will give you the path to a correct directory; make sure that directory exists, and install the Init File in it, named "`init.el`". On Unix systems, you can use `~/.emacs.d/init.el`, but under other OS's you should check. See "Init File" in the *Emacs* manual if there's any confusion.

If you already have your own Init File, you don't have to replace it. Instead, download the book's Init File to your `user-emacs-directory`, renaming the file to, say, `use-gnu-emacs.el`, and now you can simply add this line to your existing Init File to include my recommendations:

```
(with-demoted-errors "%S" (load-file (concat user-emacs-directory "use-gnu-emacs.el")))
```

If you add this line at the beginning of your existing Init File, the rest of your Init File will trump any conflicting settings; vice-versa if you add this line at the end.

The Init File

```
;; Recommended minimal starting Emacs Init File
;; extracted from the book:
;; /Use GNU Emacs: The Plain Text Computing Environment/
;; by Keith Waclena
;; https://www.lib.uchicago.edu/keith/emacs/
;;


(require 'package)
(when (< emacs-major-version 24)
  ;; For important compatibility libraries like cl-lib
```

```
  (add-to-list 'package-archives '("gnu" . "https://elpa.gnu.org/packages/")))
(when (version< emacs-version "26.3")
  ;; older emacsen < 26.3 may need this
  (setq gnutls-algorithm-priority "NORMAL:-VERS-TLS1.3"))
(with-eval-after-load 'package
  (dolist (arc '(("nongnu" . "https://elpa.nongnu.org/nongnu/")
                 ("melpa-stable" . "https://stable.melpa.org/packages/")
                 ("melpa" . "https://melpa.org/packages/")))
    (add-to-list 'package-archives arc t))
  (setq package-archive-priorities
        '(("gnu" . 10) ("nongnu" . 9) ("melpa-stable" . 8) ("melpa" . 7))))

;; thanks to an anonymous EmacsWiki coder
(defun undo-yank (arg)
  "Undo the yank you just did.  Really, adjust just-yanked text
like \\[yank-pop] does, but in the opposite direction."
  (interactive "p")
  (yank-pop (- arg)))
(keymap-global-set "C-M-y" 'undo-yank)

(setq enable-recursive-minibuffers t)

(with-eval-after-load 'chistory
  (setq list-command-history-max 120)
  (define-key command-history-map (kbd "<return>") 'command-history-repeat))

(setq completion-styles '(partial-completion substring flex))
(unless (package-installed-p 'vertico)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'vertico)))
(with-demoted-errors "%s" (vertico-mode +1))

(unless (package-installed-p 'marginalia)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'marginalia)))
(with-demoted-errors "%s" (marginalia-mode +1))

(unless (package-installed-p 'windmove)
  (with-demoted-errors "%s"
    (unless package-archive-contents
```

```
      (package-refresh-contents))
    (package-install 'windmove)))
;; <S-{left,right,up,down}> switches windows
(with-demoted-errors "%s" (windmove-default-keybindings))

(winner-mode +1) ; undo window config changes
;; add more felicitous bindings
(define-key winner-mode-map [(control c) (control left)] 'winner-undo)
(define-key winner-mode-map [(control c) (control right)] 'winner-redo)

(keymap-global-set "C-{" 'shrink-window-horizontally)
(keymap-global-set "C-}" 'enlarge-window-horizontally)
(keymap-global-set "C-^" 'enlarge-window)

(keymap-global-set "C-<" 'scroll-left)
(keymap-global-set "C->" 'scroll-right)

(undelete-frame-mode +1)               ; bring back deleted frames

(setq large-file-warning-threshold (* 100 1024 1024)) ; 100MB

(unless (version<= "29.1" emacs-version) ; no longer necessary!
  (when (version<= "27.1" emacs-version)  ; only available recently...
    (global-so-long-mode +1)))    ; speed up long lines

(setq view-read-only t)

(add-hook 'doc-view-mode-hook 'auto-revert-mode)

(add-hook 'pdf-view-mode-hook 'auto-revert-mode)

(add-hook 'dired-load-hook (lambda () (require 'dired-x)))

(setq dired-dwim-target t)  ; suggest other visible dired buffer

(unless (package-installed-p 'wgrep)
  (with-demoted-errors "%s"
    (unless package-archive-contents
      (package-refresh-contents))
    (package-install 'wgrep)))

(add-hook 'kill-emacs-query-functions
          'custom-prompt-customize-unsaved-options)
```

```
(desktop-save-mode +1)   ; restore files from previous session

(save-place-mode +1)   ; come back to where we were in that file

(keymap-global-set "C-+" 'text-scale-adjust) ; embiggen font

(setq-default indent-tabs-mode nil)      ; don't insert tabs

(setq async-shell-command-buffer 'new-buffer) ;multiple async commands ok!
(setq async-shell-command-display-buffer nil) ;don't pop up the buffer

(setq comint-buffer-maximum-size 65336) ; must be able to cat War and Peace!
(add-hook 'comint-output-filter-functions 'comint-truncate-buffer)

;; goto-address-mode is handy in these modes
(dolist (hook '(shell-mode-hook eshell-mode-hook))
  (add-hook hook #'goto-address-mode))
(add-hook 'prog-mode-hook #'goto-address-prog-mode)

(setq calendar-mark-holidays-flag t        ; colorize holidays in the calendar
      calendar-mark-diary-entries-flag t)  ; also diary entries

(setq org-agenda-include-diary t)  ; incorporate the diary into the agenda

(appt-activate +1)        ; appointment notifications, please
(require 'notifications)  ; also via desktop notifications

;; don't use a separate Frame for the control panel
(setq ediff-window-setup-function 'ediff-setup-windows-plain)
;; horizontal split is more readable
(setq ediff-split-window-function 'split-window-horizontally)

;; restore window config upon quitting ediff
(defvar ue-ediff-window-config nil "Window config before ediffing.")
(add-hook 'ediff-before-setup-hook
          (lambda ()
            (setq ue-ediff-window-config (current-window-configuration))))
(dolist (hook '(ediff-suspend-hook ediff-quit-hook))
  (add-hook hook
            (lambda ()
              (set-window-configuration ue-ediff-window-config))))

(setopt proced-enable-color-flag t)     ; colorful proced
```

```
(setq dictionary-server "dict.org")     ; we don't run our own server
```

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Index

Colophon

The version number of this book is 29.4.22; the first two components are the major and minor components of the version number of the Emacs which was used to publish the book, and the third component is the patch-level of the book.

This book is written in and published from GNU Emacs. The text consists of 22,862 lines of Org Mode markup, which, with some helpers, generates all three published versions of the book:

- the PDF version is compiled by Emacs from Org to LaTeX and then typeset with the tufte-latex classes (inspired by the beautiful typography of Edward Tufte);
- the HTML version (which uses Fabrice Niessen's ReadTheOrg) is compiled by Emacs from Org;
- and the EPUB ebook versions are compiled by Emacs from Org via TEXINFO and the GNU `texi2any(1)` command; the Kobo EPUB is generated by Patrick Gaskin's `kepubify(1)`.

Org Mode's multi-language metaprogramming facility, Babel, is used heavily to automate indexing, hypertext links to the web version of the Emacs manuals, and the many bits of statistical information in the book. The original 1997 version of this book (written in HTML preprocessed by the GNU m4 macro processor) was soon plagued by broken web links and obsolete claims about Emacs; with Babel, all these things are computed automatically every time the document is updated, so the useful lifetime of this new edition should be considerably lengthened.

There are 1,796 lines of Babel code in 7 languages (emacs-lisp, gnuplot, shell, dot, ditaa, python, org), supported by 994 more lines of custom Emacs Lisp code.

Everywhere in this book that you see very precise numbers (e.g., "1,796 lines of Babel code", "418,338 lines of hypertext reference manuals"), those numbers are probably computed by Babel code during publication. (Nice round numbers (e.g. "30,000 lines of Magit source code") are probably looked up or hand-estimated.)

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About the Author

Keith Waclena used the TECO programming language for his first paid programming job on a DECsystem-10 at Syracuse University in 1979, and discovered the original TECO Emacs shortly thereafter. Amazed and besotted, he tried to use only Emacs or at worst Emacs-like editors from that point on, continuing to use TECO Emacs on DECSYSTEM-20's at the University of Chicago, MINCE on a Z80 running ZCPR3, Freemacs on a borrowed 286 running MS-DOS, Gosling and Unipress Emacs on a Sun 3/60 and NeXT cube, and finally GNU Emacs (with temporary excursions into Epoch and XEmacs) on every computer since (whether under SunOS, BSD, System V, Solaris, NetBSD, FreeBSD, Mac OS X, MS Windows, ChromeOS, or Linux). He's been using Emacs daily for 45 years, and even after writing this book, feels like he's only scratched the surface.

He is currently a programmer at the University of Chicago Library, coding mostly in OCaml for work purposes but mostly in Emacs Lisp for personal projects.