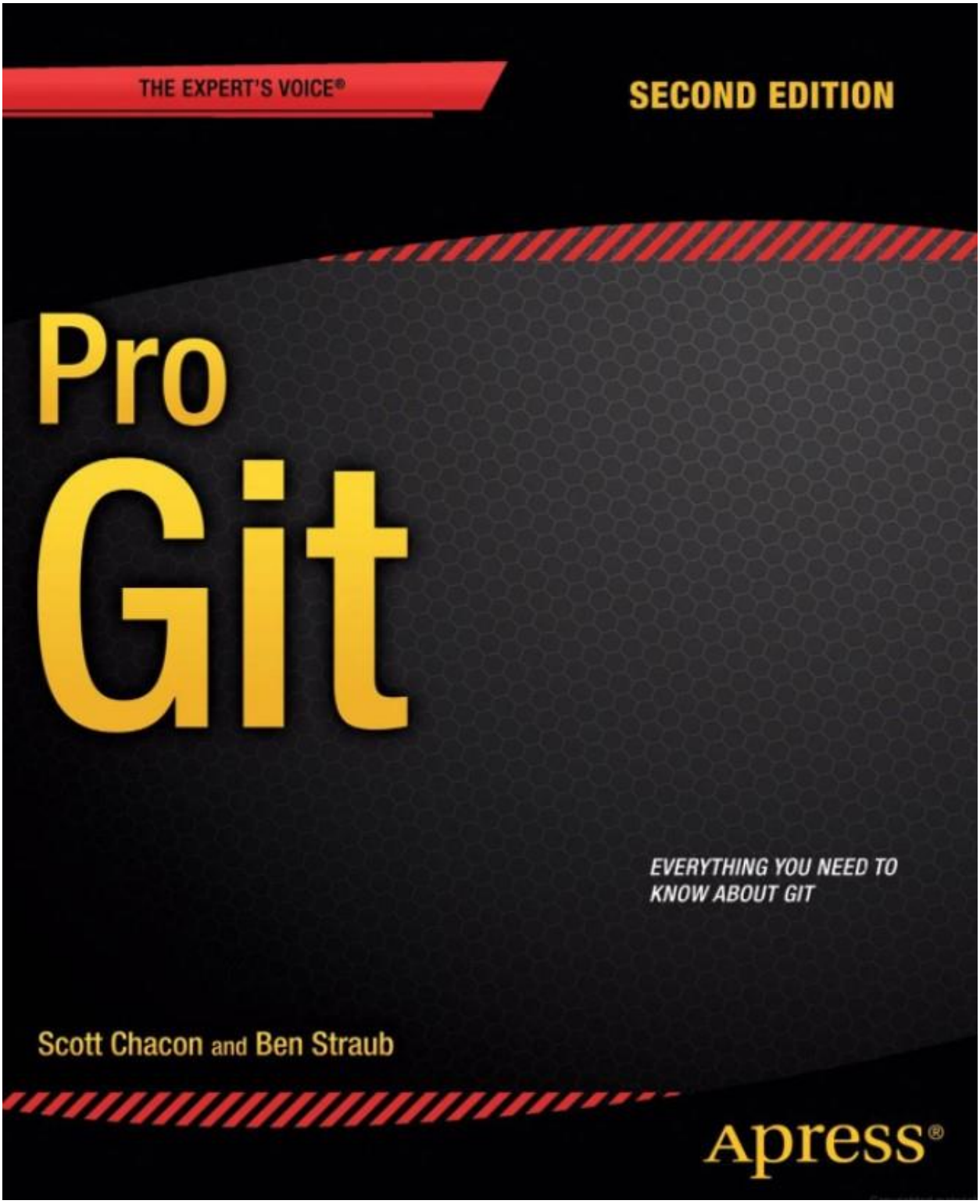
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CHAPTER 1

Getting Started

This chapter is about getting started with Git. We will begin at the beginning by explaining some background on version control tools, then move on to how to get Git running on your system and finally how to get it set up to start working with. At the end of this chapter you should understand why Git is around, why you should use it, and you should be all set up to do so.

About Version Control

What is "version control," and why should you care? Version control is a system that records changes to a file or set of files over time so that you can recall specific versions later. For the examples in this book you will use software source code as the files being version controlled, though in reality you can do this with nearly any type of file on a computer.

If you are a graphic or web designer and want to keep every version of an image or layout (which you would most certainly want to), a Version Control System (VCS) is a very wise thing to use. It allows you to revert files to a previous state, revert the entire project to a previous state, compare changes over time, see who last modified something that might be causing a problem, who introduced an issue and when, and more. Using a VCS also generally means that if you screw things up or lose files, you can easily recover. In addition, you get all this for very little overhead.

Local Version Control Systems

Many people's version-control method of choice is to copy files into another directory (perhaps a time-stamped directory, if they're clever). This approach is very common because it is so simple, but it is also incredibly error prone. It is easy to forget which directory you're in and accidentally write to the wrong file or copy over files you don't mean to.

To deal with this issue, programmers long ago developed local VCSs that had a simple database that kept all the changes to files under revision control.

Centralized Version Control Systems

The next major issue that people encounter is that they need to collaborate with developers on other systems. To deal with this problem, Centralized Version Control Systems (CVCSs) were developed. These systems, such as CVS, Subversion, and Perforce, have a single server that contains all the versioned files, and a number of clients that check out files from that central place. For many years, this has been the standard for version control.

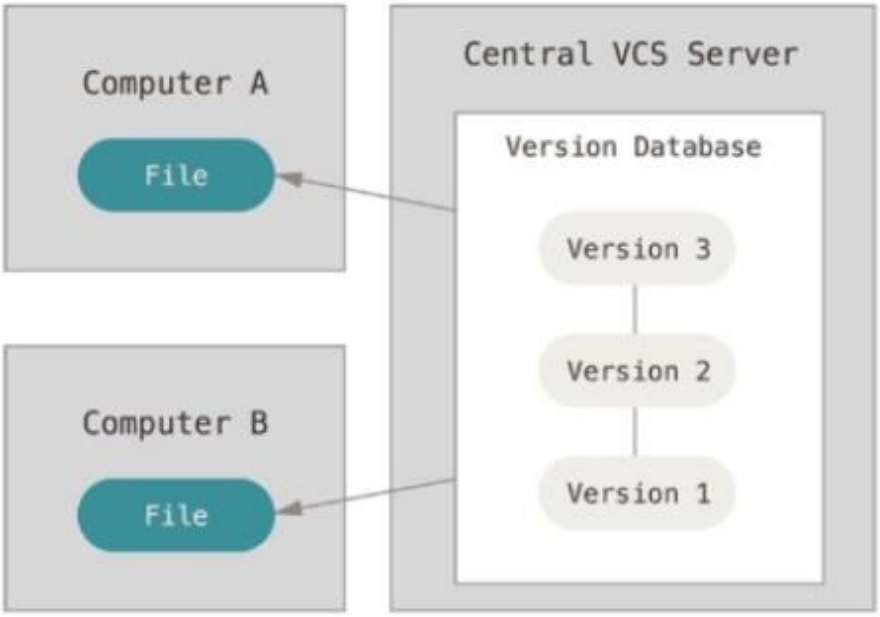

Figure 1-2. *Centralized version control*

This setup offers many advantages, especially over local VCSs. For example, everyone knows to a certain degree what everyone else on the project is doing. Administrators have fine-grained control over who can do what; and it's far easier to administer a CVCS than it is to deal with local databases on every client.

However, this setup also has some serious downsides. The most obvious is the single point of failure that the centralized server represents. If that server goes down for an hour, then during that hour nobody can collaborate at all or save versioned changes to anything they're working on. If the hard disk the central database is on becomes corrupted, and proper backups haven't been kept, you lose absolutely everything—the entire history of the project except whatever single snapshots people happen to have on their local machines. Local VCS systems suffer from this same problem—whenever you have the entire history of the project in a single place, you risk losing everything.

Distributed Version Control Systems

This is where Distributed Version Control Systems (DVCSs) step in. In a DVCS (such as Git, Mercurial, Bazaar, or Darcs), clients don't just check out the latest snapshot of the files—they fully mirror the repository. Thus if any server dies, and these systems were collaborating via it, any of the client repositories can be copied back up to the server to restore it. Every checkout is really a full backup of all the data.

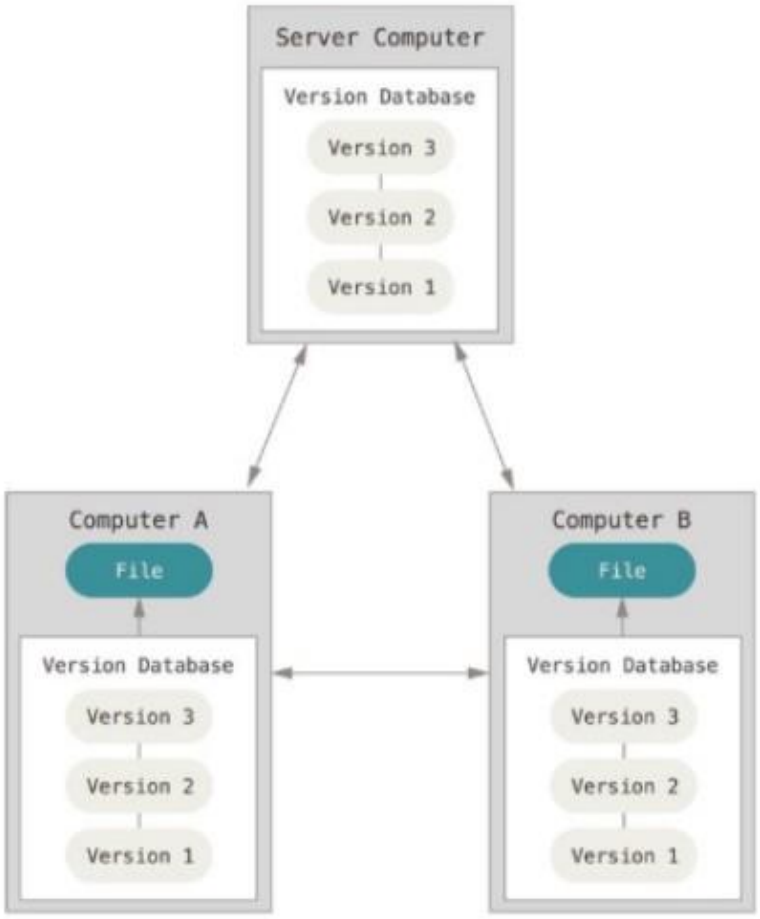

Figure 1-3. *Distributed version control*

Furthermore, many of these systems deal pretty well with having several remote repositories they can work with, so you can collaborate with different groups of people in different ways simultaneously within the same project. This allows you to set up several types of workflows that aren't possible in centralized systems, such as hierarchical models.

Snapshots, Not Differences

The major difference between Git and any other VCS (Subversion and friends included) is the way Git thinks about its data. Conceptually, most other systems store information as a list of file-based changes. These systems (CVS, Subversion, Perforce, Bazaar, and so on) think of the information they keep as a set of files and the changes made to each file over time.

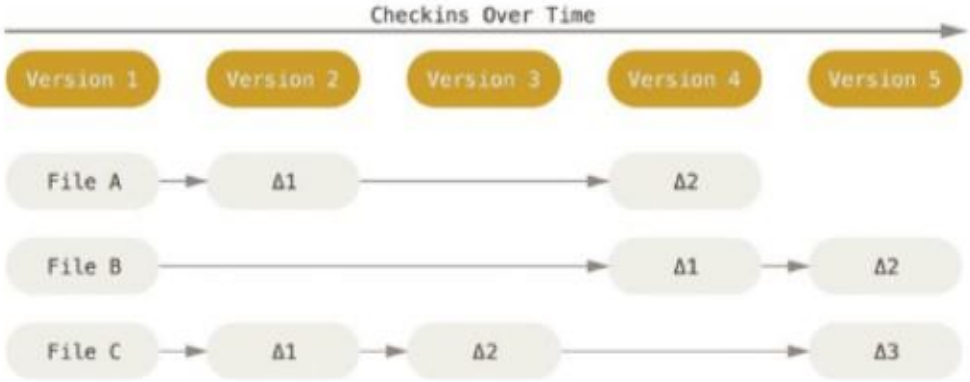

Figure 1-4. *Storing data as changes to a base version of each file*

Git doesn't think of or store its data this way. Instead, Git thinks of its data more like a set of snapshots of a miniature filesystem. Every time you commit, or save the state of your project in Git, it basically takes a picture of what all your files look like at that moment and stores a reference to that snapshot. To be efficient, if files have not changed, Git doesn't store the file again, just a link to the previous identical file it has already stored. Git thinks about its data more like a *stream of snapshots*.

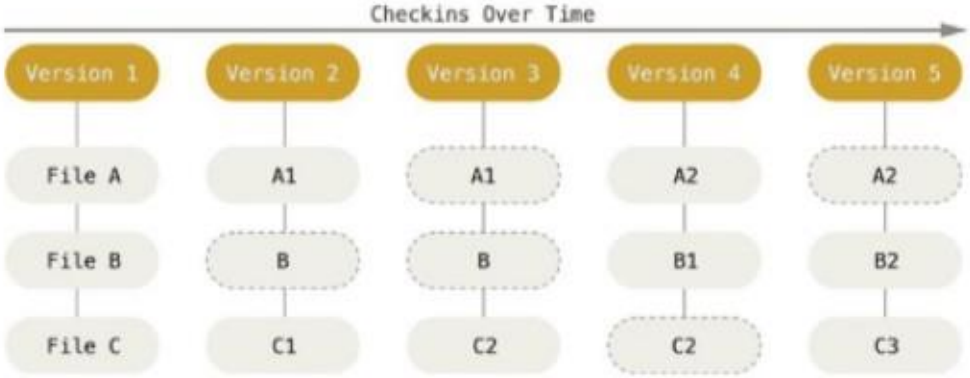

Figure 1-5. *Storing data as snapshots of the project over time*

This is an important distinction between Git and nearly all other VCSs. It makes Git reconsider almost every aspect of version control that most other systems copied from the previous generation. This makes Git more like a mini filesystem with some incredibly powerful tools built on top of it, rather than simply a VCS. We'll explore some of the benefits you gain by thinking of your data this way when we cover Git branching in Chapter 3.

Nearly Every Operation Is Local

Most operations in Git only need local files and resources to operate—generally no information is needed from another computer on your network. If you're used to a CVCS where most operations have that network latency overhead, this aspect of Git will make you think that the gods of speed have blessed Git with unworldly powers. Because you have the entire history of the project right there on your local disk, most operations seem almost instantaneous.

For example, to browse the history of the project, Git doesn't need to go out to the server to get the history and display it for you—it simply reads it directly from your local database. This means you see the project history almost instantly. If you want to see the changes introduced between the current version of a file and the file a month ago, Git can look up the file a month ago and do a local difference calculation, instead of having to either ask a remote server to do it or pull an older version of the file from the remote server to do it locally.

This also means that there is very little you can't do if you're offline or off VPN. If you get on an airplane or a train and want to do a little work, you can commit happily until you get to a network connection to upload. If you go home and can't get your VPN client working properly, you can still work. In many other systems, doing so is either impossible or painful. In Perforce, for example, you can't do much when you aren't connected to the server; and in Subversion and CVS, you can edit files, but you can't commit changes to your database (because your database is offline). This may not seem like a huge deal, but you may be surprised what a big difference it can make.

Git Has Integrity

Everything in Git is check-summed before it is stored and is then referred to by that checksum. This means it's impossible to change the contents of any file or directory without Git knowing about it. This functionality is built in to Git at the lowest levels and is integral to its philosophy. You can't lose information in transit or get file corruption without Git being able to detect it.

The mechanism that Git uses for this checksumming is called a SHA-1 hash. This is a 40-character string composed of hexadecimal characters (0–9 and a–f) and calculated based on the contents of a file or directory structure in Git. A SHA-1 hash looks something like this:

```
24b9da6552252987aa493b52f8696cd6d3b00373
```

You will see these hash values all over the place in Git because it uses them so much. In fact, Git stores everything in its database not by filename but by the hash value of its contents.

Git Generally Only Adds Data

When you do actions in Git, nearly all of them only add data to the Git database. It is hard to get the system to do anything that is not undoable or to make it erase data in any way. As in any VCS, you can lose or mess up changes you haven't committed yet; but after you commit a snapshot into Git, it is very difficult to lose, especially if you regularly push your database to another repository.

This makes using Git a joy because we know we can experiment without the danger of severely screwing things up.

The Three States

Now, pay attention. This is the main thing to remember about Git if you want the rest of your learning process to go smoothly. Git has three main states that your files can reside in: committed, modified, and staged. *Committed* means that the data is safely stored in your local database. *Modified* means that you have changed the file but have not committed it to your database yet. *Staged* means that you have marked a modified file in its current version to go into your next commit snapshot.

This leads us to the three main sections of a Git project: the Git directory, the working directory, and the staging area.

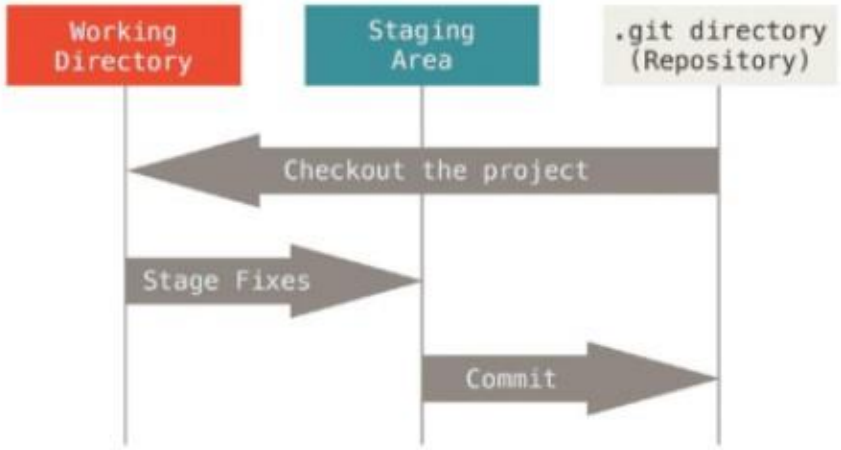

Figure 1-6. *Working directory, staging area, and Git directory*

The Git directory is where Git stores the metadata and object database for your project. This is the most important part of Git, and it is what is copied when you clone a repository from another computer.

The working directory is a single checkout of one version of the project. These files are pulled out of the compressed database in the Git directory and placed on disk for you to use or modify.

The staging area is a file, generally contained in your Git directory, that stores information about what will go into your next commit. It's sometimes referred to as the "index", but it's also common to refer to it as the staging area.

The basic Git workflow goes something like this:

1. You modify files in your working directory.
2. You stage the files, adding snapshots of them to your staging area.
3. You do a commit, which takes the files as they are in the staging area and stores that snapshot permanently to your Git directory.

If a particular version of a file is in the Git directory, it's considered committed. If it's modified but has been added to the staging area, it is staged. And if it was changed since it was checked out but has not been staged, it is modified. In Chapter 2, you'll learn more about these states and how you can either take advantage of them or skip the staged part entirely.

Figure 1-7. *Git OS X Installer*

You can also install it as part of the GitHub for Mac install. Their GUI Git tool has an option to install command line tools as well. You can download that tool from the GitHub for Mac website, at `http://mac.github.com`.

Installing on Windows

There are also a few ways to install Git on Windows. The most official build is available for download on the Git website. Just go to `http://git-scm.com/download/win` and the download will start automatically. Note that this is a project called Git for Windows (also called msysGit), which is separate from Git itself; for more information on it, go to `http://msysgit.github.io/`.

Another easy way to get Git installed is by installing GitHub for Windows. The installer includes a command line version of Git as well as the GUI. It also works well with Powershell, and sets up solid credential caching and sane CRLF settings. We'll learn more about those things a little later, but suffice it to say they're things you want. You can download this from the GitHub for Windows website, at `http://windows.github.com`.

Some people may instead find it useful to install Git from source, because you'll get the most recent version. The binary installers tend to be a bit behind, though as Git has matured in recent years, this has made less of a difference.

If you do want to install Git from source, you need to have the following libraries that Git depends on: `curl`, `zlib`, `openssl`, `expat`, and `libiconv`. For example, if you're on a system that has `yum` (such as Fedora) or `apt-get` (such as a Debian-based system), you can use one of these commands to install all of the dependencies:

```
$ yum install curl-devel expat-devel gettext-devel \
  openssl-devel zlib-devel

$ apt-get install libcurl4-gnutls-dev libexpat1-dev gettext \
  libz-dev libssl-dev
```

When you have all the necessary dependencies, you can go ahead and grab the latest tagged release tarball from several places. You can get it via the Kernel.org site, at `https://www.kernel.org/pub/software/scm/git`, or the

mirror on the GitHub web site, at https://github.com/git/git/releases. It's generally a little clearer what the latest version is on the GitHub page, but the kernel.org page also has release signatures if you want to verify your download.

Then, compile and install:

```
$ tar -zxf git-1.9.1.tar.gz
$ cd git-1.9.1
$ make configure
$ ./configure --prefix=/usr
$ make all doc info
$ sudo make install install-doc install-html install-info
```

After this is done, you can also get Git via Git itself for updates:

```
$ git clone git://git.kernel.org/pub/scm/git/git.git
```

First-Time Git Setup

Now that you have Git on your system, you'll want to do a few things to customize your Git environment. You should have to do these things only once on any given computer; they'll stick around between upgrades. You can also change them at any time by running through the commands again.

Git comes with a tool called `git config` that lets you get and set configuration variables that control all aspects of how Git looks and operates. These variables can be stored in three different places:

- `/etc/gitconfig` file: Contains values for every user on the system and all their repositories. If you pass the option `--system` to `git config`, it reads and writes from this file specifically.
- `~/.gitconfig` or `~/.config/git/config` file: Specific to your user. You can make Git read and write to this file specifically by passing the `--global` option.
- `config` file in the Git directory (that is, `.git/config`) of whatever repository you're currently using: Specific to that single repository.

Each level overrides values in the previous level, so values in `.git/config` trump those in `/etc/gitconfig`.

On Windows systems, Git looks for the `.gitconfig` file in the `$HOME` directory (`C:\Users\$USER` for most people). It also still looks for `/etc/gitconfig`, although it's relative to the MSys root, which is wherever you decide to install Git on your Windows system when you run the installer.

Your Identity

The first thing you should do when you install Git is to set your user name and e-mail address. This is important because every Git commit uses this information, and it's immutably baked into the commits you start creating:

```
$ git config --global user.name "John Doe"
$ git config --global user.email johndoe@example.com
```

Again, you need to do this only once if you pass the `--global` option, because then Git will always use that information for anything you do on that system. If you want to override this with a different name or e-mail address for specific projects, you can run the command without the `--global` option when you're in that project.

Many of the GUI tools will help you do this when you first run them.

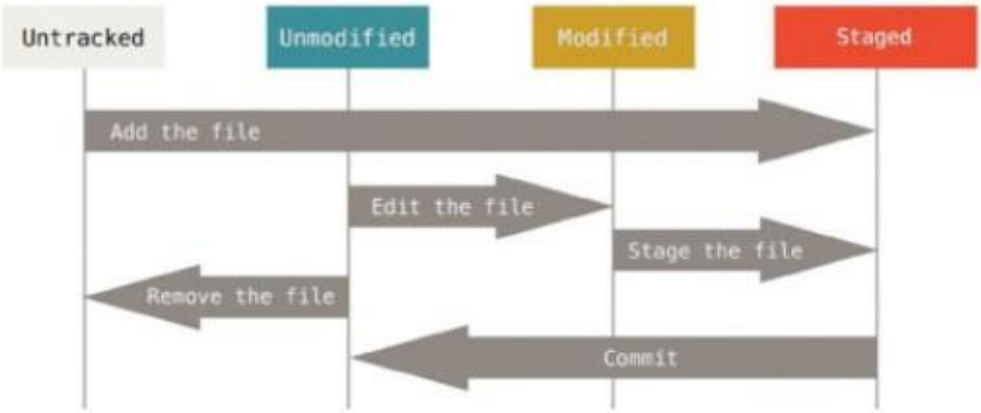

Figure 2-1. *The lifecycle of the status of your files*

Checking the Status of Your Files

The main tool you use to determine which files are in which state is the `git status` command. If you run this command directly after a clone, you should see something like this:

```
$ git status
On branch master
nothing to commit, working directory clean
```

This means you have a clean working directory—in other words, there are no tracked and modified files. Git also doesn't see any untracked files, or they would be listed here. Finally, the command tells you which branch you're on and informs you that it has not diverged from the same branch on the server. For now, that branch is always "master," which is the default; you won't worry about it here. Branches and references are discussed in detail in Chapter 3.

Let's say you add a new file to your project, a simple README file. If the file didn't exist before, and you run `git status`, you see your untracked file like so:

```
$ echo 'My Project' > README
$ git status
On branch master
Untracked files:
  (use "git add <file>..." to include in what will be committed)

    README

nothing added to commit but untracked files present (use "git add" to track)
```

You can see that your new README file is untracked, because it's under the "Untracked files" heading in your status output. Untracked basically means that Git sees a file you didn't have in the previous snapshot (commit); Git won't start including it in your commit snapshots until you explicitly tell it to do so. It does this so you don't accidentally begin including generated binary files or other files that you did not mean to include. You do want to start including README, so let's start tracking the file.