You Got a Package

In this chapter, you will learn how to manage software applications on your Linux system. You will learn how to use the Debian package manager to download, install, remove, search, and update software packages.

# What is a package?

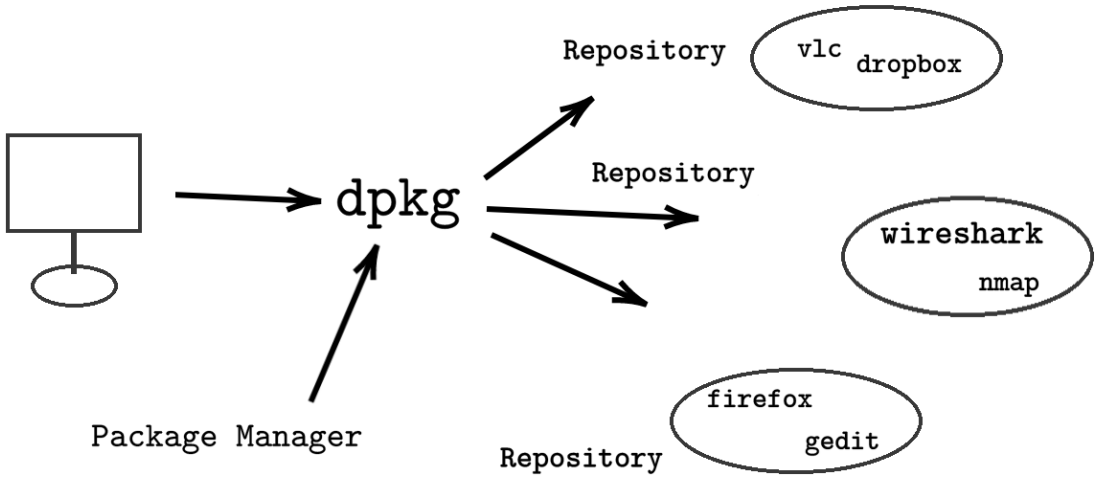
In Linux, a package is a compressed archive file that contains all the necessary files for a particular software application to run. For example, a web browser like Firefox comes in a package that has all the files needed for Firefox to run.

# The role of a package manager

Package managers are programs that we use in Linux to manage packages; that is, to download, install, remove, search, and update packages. Keep in mind that different Linux distributions have different package managers. For example, [dpkg], which stands for Debian package manager, is the package manager for Ubuntu and other Debian-based Linux distributions. On the other hand, RedHat-based Linux distributions like Fedora and CentOS use [rpm], which stands for RedHat Package Manager. Other Linux distributions like SUSE use [zypper] as the package manager and so on.

# Where do packages come from?

Very rarely will you find experienced Linux users going to a website to download a software package as Windows or macOS users do. Instead, each Linux distribution has its list of sources from where it gets the majority of its software packages. These sources are also referred to as **repositories**. The following figure illustrates the process of downloading packages on your Linux system:




# How to download packages

On Ubuntu and other Debian Linux distributions, you can use the command-line utility [apt-get] to manage packages. Behind the scenes, [apt-get] makes use of the package manager [dpkg]. To download a package, you can run the command [apt-get download] followed by the package name:

```
apt-get download package_name
```

As the [root] user, change to the [/tmp] directory:

```
root@ubuntu-linux:~# cd /tmp
```

To download the [cmatrix] package, you can run the command:

```
root@ubuntu-linux:/tmp# apt-get download cmatrix
Get:1 http://ca.archive.ubuntu.com/ubuntu bionic/universe amd64 cmatrix amd64
1.2a-5build3 [16.1 kB]
Fetched 16.1 kB in 1s (32.1 kB/s)
```

The [cmatrix] package will be downloaded in [/tmp]:

```
root@ubuntu-linux:/tmp# ls
cmatrix_1.2a-5build3_amd64.deb
```

Notice the [.deb] extension in the package name, which signals that it's a Debian package. On RedHat distributions, package names end with the [.rpm] extension. You can list the files inside the [cmatrix] package by running the command [dpkg -c] as follows:

```
root@ubuntu-linux:/tmp# dpkg -c cmatrix_1.2a-5build3_amd64.deb
drwxr-xr-x root/root     0 2018-04-03 06:17 ./
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/bin/
-rwxr-xr-x root/root 18424 2018-04-03 06:17 ./usr/bin/cmatrix
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/consolefonts/
-rw-r--r-- root/root  4096 1999-05-13 08:55 ./usr/share/consolefonts/matrix.fnt
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/doc/
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/doc/cmatrix/
-rw-r--r-- root/root  2066 2000-04-03 19:29 ./usr/share/doc/cmatrix/README
-rw-r--r-- root/root   258 1999-05-13 09:12 ./usr/share/doc/cmatrix/TODO
-rw-r--r-- root/root  1128 2018-04-03 06:17 ./usr/share/doc/cmatrix/copyright
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/man/
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/man/man1/
-rw-r--r-- root/root   932 2018-04-03 06:17 ./usr/share/man/man1/cmatrix.1.gz
drwxr-xr-x root/root     0 2018-04-03 06:17 ./usr/share/menu/
-rw-r--r-- root/root   392 2018-04-03 06:17 ./usr/share/menu/cmatrix
```

Notice that we only downloaded the package, but we didn't install it yet. Nothing will happen if you run the [cmatrix] command:

```
root@ubuntu-linux:/tmp# cmatrix
bash: /usr/bin/cmatrix: No such file or directory
```

# How to install packages

You can use the [-i] option with the [dpkg] command to install a downloaded package:

```
root@ubuntu-linux:/tmp# dpkg -i cmatrix_1.2a-5build3_amd64.deb
Selecting previously unselected package cmatrix.
(Reading database ... 178209 files and directories currently installed.) Preparing to
unpack cmatrix_1.2a-5build3_amd64.deb ...
Unpacking cmatrix (1.2a-5build3) ...
Setting up cmatrix (1.2a-5build3) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
root@ubuntu-linux:/tmp#
```

And that's it! Now run the [cmatrix] command:

```
root@ubuntu-linux:/tmp# cmatrix
```

You will see the matrix running on your terminal like in the following image:

We have taken the long way to install the [cmatrix] package. We first downloaded the package, and then we installed it. You can install a package right away (without downloading it) by running the command [apt-get install] followed by the package name:

```
apt-get install package_name
```

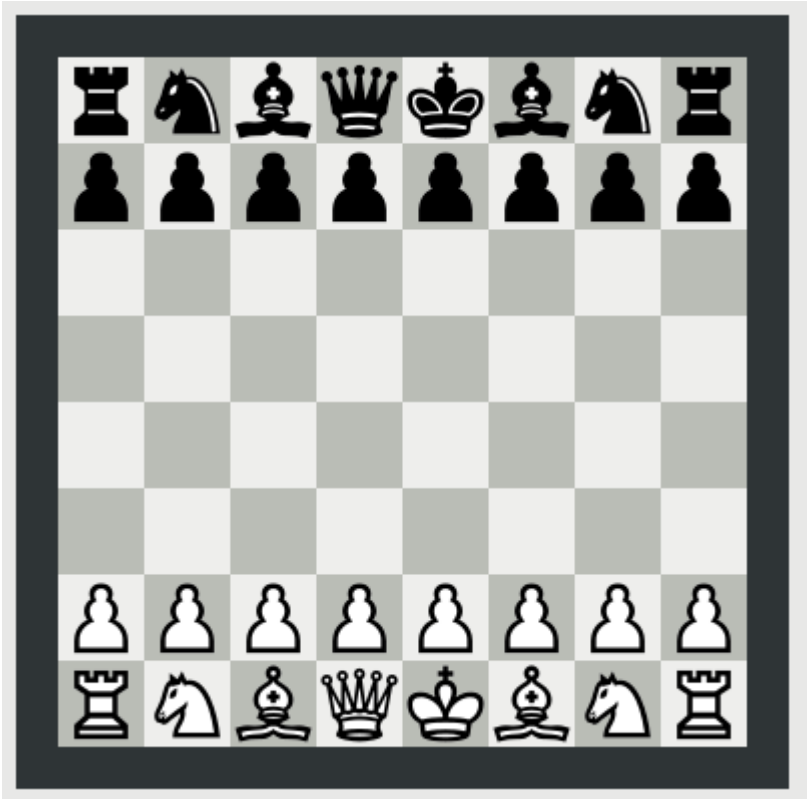
For example, you can install the **GNOME Chess** game by running the command:

```
root@ubuntu-linux:/tmp# apt-get install gnome-chess
Reading package lists... Done
Building dependency tree
Reading state information... Done
Suggested packages:
  bbchess crafty fairymax fruit glaurung gnuchess phalanx sjeng stockfish toga2
The following NEW packages will be installed:
  gnome-chess
0 upgraded, 1 newly installed, 0 to remove and 357 not upgraded.
Need to get 0 B/1,514 kB of archives.
After this operation, 4,407 kB of additional disk space will be used.
```

```
Selecting previously unselected package gnome-chess.
(Reading database ... 178235 files and directories currently installed.) Preparing to
unpack .../gnome-chess_1%3a3.28.1-1_amd64.deb ...
Unpacking gnome-chess (1:3.28.1-1) ...
Processing triggers for mime-support (3.60ubuntu1) ...
Processing triggers for desktop-file-utils (0.23-1ubuntu3.18.04.2) ...
Processing triggers for libglib2.0-0:amd64 (2.56.3-0ubuntu0.18.04.1) ...
Setting up gnome-chess (1:3.28.1-1) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
Processing triggers for gnome-menus (3.13.3-11ubuntu1.1) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
```

Now you can start the game by running the [gnome-chess] command:

```
root@ubuntu-linux:/tmp# gnome-chess
```



# How to remove packages

You can easily remove a package by running the command [apt-get remove] followed by the package name:

```
apt-get remove package_name
```

For example, if you are tired of the matrix lifestyle and have decided to remove the [cmatrix] package, you can run:

```
root@ubuntu-linux:/tmp# apt-get remove cmatrix
Reading package lists... Done
```

```
Building dependency tree
Reading state information... Done
The following packages will be REMOVED:
    cmatrix
0 upgraded, 0 newly installed, 1 to remove and 357 not upgraded.
After this operation, 49.2 kB disk space will be freed.
Do you want to continue? [Y/n] y
(Reading database ... 178525 files and directories currently installed.)
Removing cmatrix (1.2a-5build3) ...
Processing triggers for man-db (2.8.3-2ubuntu0.1) ...
```

Now, if you run the [cmatrix] command, you will get an error:

```
root@ubuntu-linux:/tmp# cmatrix
Command 'cmatrix' not found, but can be installed with:
apt install cmatrix
```

The [apt-get remove] command removes (uninstalls) a package, but it doesn't remove the package configuration files. You can use the [apt-get purge] command to remove a package along with its configuration files.

For example, if you want to remove the [gnome-chess] package along with its configuration files, you can run:

```
root@ubuntu-linux:/tmp# apt-get purge gnome-chess
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following package was automatically installed and is no longer required:
  hoichess
Use 'apt autoremove' to remove it.
The following packages will be REMOVED:
  gnome-chess*
0 upgraded, 0 newly installed, 1 to remove and 357 not upgraded.
After this operation, 4,407 kB disk space will be freed.
Do you want to continue? [Y/n] y
(Reading database ... 178515 files and directories currently installed.)
Removing gnome-chess (1:3.28.1-1) ...
Processing triggers for mime-support (3.60ubuntu1) ...
Processing triggers for desktop-file-utils (0.23-1ubuntu3.18.04.2) ...
Processing triggers for libglib2.0-0:amd64 (2.56.3-0ubuntu0.18.04.1) ... Processing
triggers for man-db (2.8.3-2ubuntu0.1) ...
Processing triggers for gnome-menus (3.13.3-11ubuntu1.1) ...
Processing triggers for hicolor-icon-theme (0.17-2) ...
(Reading database ... 178225 files and directories currently installed.)
Purging configuration files for gnome-chess (1:3.28.1-1) ...
```

You can even see in the last line in the output it says [Purging configuration files for gnome-chess (1:3.28.1-1) ...], which means that the configuration files for [gnome-chess] are being removed as well.

# How to search for packages

Sometimes you are unsure of a package name. Then, in this case, you can't install it until you look it up. You can search for a package by using the command [apt-cache search] followed by your search term or keyword:

```
apt-cache search keyword
```

For example, let's say that you want to install the [wireshark] package, but you can only remember that the package name has the word [shark] in it. In this case, you can run the command:

```
root@ubuntu-linux:/tmp# apt-cache search shark
dopewars - drug-dealing game set in streets of New York City
dopewars-data - drug-dealing game set in streets of New York City - data files
forensics-extra - Forensics Environment - extra console components (metapackage)
kernelshark - Utilities for graphically analyzing function tracing in the kernel
libcrypto++-dev - General purpose cryptographic library - C++ development libshark-dev
- development files for Shark
libshark0 - Shark machine learning library
libwireshark-data - network packet dissection library -- data files
libwireshark-dev - network packet dissection library -- development files
libwireshark10 - network packet dissection library -- shared library
libwiretap-dev - network packet capture library -- development files
libwsutil-dev - network packet dissection utilities library -- development files
libwsutil8 - network packet dissection utilities library -- shared library netmate -
netdude clone that shows pcap dump lines in network header style plowshare-modules -
plowshare drivers for various file sharing websites
shark-doc - documentation for Shark
tcpxtract - extract files from network traffic based on file signatures
tshark - network traffic analyzer - console version
wifite - Python script to automate wireless auditing using aircrack-ng tools wireshark
- network traffic analyzer - meta-package
wireshark-common - network traffic analyzer - common files
wireshark-dev - network traffic analyzer - development tools
wireshark-doc - network traffic analyzer - documentation
wireshark-gtk - network traffic analyzer - GTK+ version
wireshark-qt - network traffic analyzer - Qt version
zeitgeist-explorer - GUI application for monitoring and debugging zeitgeist forensics-
extra-gui - Forensics Environment - extra GUI components (metapackage) horst - Highly
Optimized Radio Scanning Tool
libvirt-wireshark - Wireshark dissector for the libvirt protocol
libwiretap7 - network packet capture library -- shared library
libwscodecs1 - network packet dissection codecs library -- shared library minetest-
mod-animals - Minetest mod providing animals
nsntrace - perform network trace of a single process by using network namespaces
libwireshark11 - network packet dissection library -- shared library
libwiretap8 - network packet capture library -- shared library
libwscodecs2 - network packet dissection codecs library -- shared library libwsutil9 -
network packet dissection utilities library -- shared library
```

And you are bombarded with a massive output that lists all the package names that have the word [shark] in their package description. I bet you can spot the package [wireshark] in the middle of the output. We can get a much shorter and a refined output by using the [-n] option:

```
root@ubuntu-linux:/tmp# apt-cache -n search shark
kernelshark - Utilities for graphically analyzing function tracing in the kernel
libshark-dev - development files for Shark
libshark0 - Shark machine learning library
```

```
libwireshark-data - network packet dissection library -- data files
libwireshark-dev - network packet dissection library -- development files
libwireshark10 - network packet dissection library -- shared library
shark-doc - documentation for Shark
tshark - network traffic analyzer - console version
wireshark - network traffic analyzer - meta-package
wireshark-common - network traffic analyzer - common files
wireshark-dev - network traffic analyzer - development tools
wireshark-doc - network traffic analyzer - documentation
wireshark-gtk - network traffic analyzer - GTK+ version
wireshark-qt - network traffic analyzer - Qt version
libndpi-wireshark - extensible deep packet inspection library - wireshark dissector

libvirt-wireshark - Wireshark dissector for the libvirt protocol
libwireshark11 - network packet dissection library -- shared library
```

This will only list the packages that have the word [shark] in their package names. Now, you can install [wireshark] by running the command:

```
root@ubuntu-linux:/tmp# apt-get install wireshark
```

# How to show package information

To view package information, you can use the command [apt-cache show] followed by the package name:

```
apt-cache show package_name
```

For example, to display the [cmatrix] package information, you can run:

```
root@ubuntu-linux:~# apt-cache show cmatrix
Package: cmatrix
Architecture: amd64
Version: 1.2a-5build3
Priority: optional
Section: universe/misc
Origin: Ubuntu
Maintainer: Ubuntu Developers <ubuntu-devel-discuss@lists.ubuntu.com>
Original-Maintainer: Diego Fernández Durán <diego@goedi.net>
Bugs: https://bugs.launchpad.net/ubuntu/+filebug
Installed-Size: 48
Depends: libc6 (>= 2.4), libncurses5 (>= 6), libtinfo5 (>= 6)
Recommends: kbd
Suggests: cmatrix-xfont
Filename: pool/universe/c/cmatrix/cmatrix_1.2a-5build3_amd64.deb
Size: 16084
MD5sum: 8dad2a99d74b63cce6eeff0046f0ac91
SHA1: 3da3a0ec97807e6f53de7653e4e9f47fd96521c2
SHA256: cd50212101bfd71479af41e7afc47ea822c075ddb1ceed83895f8eaa1b79ce5d Homepage:
http://www.asty.org/cmatrix/
Description-en_CA: simulates the display from "The Matrix"
Screen saver for the terminal based in the movie "The Matrix".
 * Support terminal resize.
```

```
 * Screen saver mode: any key closes it.
 * Selectable color.
 * Change text scroll rate.
Description-md5: 9af1f58e4b6301a6583f036c780c6ae6
```

You can see a lot of useful information in the output, including the package description and the contact information of the maintainer of the package, which is useful if you find a bug and want to report it. You will also find out if the package depends on (requires) other packages.

**Package dependency** can turn into a nightmare, and so I highly recommend that you use the [apt-get install] command to install a package whenever possible as it checks and resolves package dependency while installing a package. On the other hand, the [dpkg -i] command doesn't check for package dependency. Keep that in mind!

You can use the [apt-cache depends] command to list package dependencies:

```
apt-cache depends package_name
```

For example, to view the list of packages that are needed to be installed for [cmatrix] to work properly, you can run the command:

```
root@ubuntu-linux:~# apt-cache depends cmatrix
cmatrix
  Depends: libc6
  Depends: libncurses5
  Depends: libtinfo5
  Recommends: kbd
  Suggests: cmatrix-xfont
```

As you can see, the [cmatrix] package depends on three packages:

- [libc6]
- [libncurses5]
- [libtinfo5]

Those three packages have to be installed on the system in order for [cmatrix] to run properly.

# Listing all packages

You can use the [dpkg -l] command to list all the packages that are installed on your system:

```
root@ubuntu-linux:~# dpkg -l
```

You can also use the [apt-cache pkgnames] command to list all the packages that are available for you to install:

```
root@ubuntu-linux:~# apt-cache pkgnames
libdatrie-doc
libfstrcmp0-dbg
libghc-monadplus-doc
librime-data-sampheng
python-pyao-dbg
fonts-georgewilliams
python3-aptdaemon.test
libcollada2gltfconvert-dev
python3-doc8
```

```
r-bioc-hypergraph
.
.
.
.
.
```

You can pipe the output to the [wc -l] command to get the total number of available packages:

```
root@ubuntu-linux:~# apt-cache pkgnames | wc -l 64142
```

Wow! That's a massive number; over 64,000 available packages on my system.

You may also be interested to know which repositories (sources) your system used to obtain all these packages. These repositories are included in the file [/etc/ap- t/sources.list] and in any file with the suffix [.list] under the directory [/etc/apt/- sources.list.d/]. You can check the [man] page:

```
root@ubuntu-linux:~# man sources.list
```

To learn how you can add a repository to your system.

You can also use the [apt-cache policy] command to list all the enabled repositories on your system:

```
root@ubuntu-linux:~# apt-cache policy
Package files:
100 /var/lib/dpkg/status
    release a=now
500 http://dl.google.com/linux/chrome/deb stable/main amd64
    Packages release v=1.0,o=Google LLC,a=stable,n=stable,l=Google,c=main,
    b=amd64 origin dl.google.com
100 http://ca.archive.ubuntu.com/ubuntu bionic-backports/main i386
    Packages release v=18.04,o=Ubuntu,a=bionic-backports,n=bionic,l=Ubuntu,
    c=main,b=i386 origin ca.archive.ubuntu.com
100 http://ca.archive.ubuntu.com/ubuntu bionic-backports/main amd64
    Packages release v=18.04,o=Ubuntu,a=bionic-backports,n=bionic,l=Ubuntu,
    c=main,b=amd64 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/multiverse i386
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,
    l=Ubuntu,c=multiverse,b=i386 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/multiverse amd64
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,l=Ubuntu,
    c=multiverse,b=amd64 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/universe i386
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,l=Ubuntu,
    c=universe,b=i386 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/universe amd64
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,l=Ubuntu,
    c=universe,b=amd64 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/restricted i386
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,l=Ubuntu,
    c=restricted,b=i386 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/restricted amd64
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,l=Ubuntu,
    c=restricted,b=amd64 origin ca.archive.ubuntu.com
```

```
500 http://ca.archive.ubuntu.com/ubuntu bionic/main i386
    Packages release v=18.04,o=Ubuntu,a=bionic,
    n=bionic,l=Ubuntu,c=main,b=i386 origin ca.archive.ubuntu.com
500 http://ca.archive.ubuntu.com/ubuntu bionic/main amd64
    Packages release v=18.04,o=Ubuntu,a=bionic,n=bionic,
    l=Ubuntu,c=main,b=amd64 origin ca.archive.ubuntu.com
Pinned packages:
```

If you are eager to know which repository provides a specific package, you can use the [apt-cache policy] command followed by the package name:

```
apt-cache policy package_name
```

For example, to know which repository provides the [cmatrix] package, you can run:

```
root@ubuntu-linux:~# apt-cache policy cmatrix
cmatrix:
  Installed: 1.2a-5build3
  Candidate: 1.2a-5build3
  Version table:
*** 1.2a-5build3 500
    500 http://ca.archive.ubuntu.com/ubuntu bionic/universe amd64 Packages
    100 /var/lib/dpkg/status
```

From the output, you can see that the [cmatrix] package comes from the bionic/universe repository at http://ca.archive.ubuntu.com/ubuntu.

# Patching your system

If a newer release for a package is available, then you can upgrade it using the [apt-get install --only-upgrade] command followed by the package name:

```
apt-get install --only-upgrade package_name
```

For example, you can upgrade the [nano] package by running the command:

```
root@ubuntu-linux:~# apt-get install --only-upgrade nano
Reading package lists... Done
Building dependency tree
Reading state information... Done
nano is already the newest version (2.9.3-2).
The following package was automatically installed and is no longer required:
  hoichess
Use 'apt autoremove' to remove it.
0 upgraded, 0 newly installed, 0 to remove and 357 not upgraded.
```

You can also upgrade all the installed packages on your system by running the commands:

1. [apt-get update]
2. [apt-get upgrade]

The first command [apt-get update] will update the list of available packages and their versions, but it doesn't do any installation or upgrade:

```
root@ubuntu-linux:~# apt-get update
Ign:1 http://dl.google.com/linux/chrome/deb stable InRelease
Hit:2 http://ca.archive.ubuntu.com/ubuntu bionic InRelease
Hit:3 http://ppa.launchpad.net/linuxuprising/java/ubuntu bionic InRelease
Hit:4 http://dl.google.com/linux/chrome/deb stable Release
Hit:5 http://security.ubuntu.com/ubuntu bionic-security InRelease
Hit:6 http://ca.archive.ubuntu.com/ubuntu bionic-updates InRelease
Hit:8 http://ca.archive.ubuntu.com/ubuntu bionic-backports InRelease
Reading package lists... Done
```

The second command [apt-get upgrade] will upgrade all the installed packages on your system:

```
root@ubuntu-linux:~# apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following package was automatically installed and is no longer required:
  hoichess
Use 'apt autoremove' to remove it.
The following packages have been kept back:
  gstreamer1.0-gl libcogl20 libgail-3-0 libgl1-mesa-dri libgstreamer-gl1.0-0
  libreoffice-calc libreoffice-core libreoffice-draw libreoffice-gnome
    libreoffice-gtk3
  libwayland-egl1-mesa libxatracker2 linux-generic linux-headers-generic
  software-properties-common software-properties-gtk ubuntu-desktop
The following packages will be upgraded:
  apt apt-utils aptdaemon aptdaemon-data aspell base-files bash bind9-host bluez
  python2.7-minimal python3-apt python3-aptdaemon python3-aptdaemon.gtk3widgets
  python3-problem-report python3-update-manager python3-urllib3 python3.6
342 upgraded, 0 newly installed, 0 to remove and 30 not upgraded.
Need to get 460 MB of archives.
After this operation, 74.3 MB of additional disk space will be used.
Do you want to continue? [Y/n]
```

Remember that order matters; that is, you need to run the [apt-get update] command before you run the [apt-get upgrade] command.

In Linux lingo, the process of upgrading all the installed packages on your system is called **patching the system**.

# Knowledge check

For the following exercises, open up your Terminal and try to solve the following tasks:

1. Install the [tmux] package on your system.
2. List all the dependencies of the [vim] package.
3. Install the [cowsay] package on your system.
4. Remove the [cowsay] package along with all its configuration files.
5. Upgrade all the packages on your system (patch your system).