Installing PostgreSQL

Installing PostgreSQL

- PostgreSQL can be installed on almost all modern operating systems.
- It can be installed on all recent Linux distributions, Windows 2000 SP4 and later, FreeBSD, OpenBSD, macOS, AIX, and Solaris.
- Also, PostgreSQL can work on various CPU architectures, including x86, x86_64, and IA64.
- You can check whether a platform (operating system and CPU architecture combination) is supported by exploring the PostgreSQL build farm at http://buildfarm.postgresql.org.
- You can compile and install.

- In order to automate PostgreSQL installation and to reduce server administrative tasks, it's recommended you use PostgreSQL binaries, which come with the operating system packaging system.
- This approach normally has one drawback: binaries that aren't up to date.
- However, PostgreSQL's official website maintains the binaries for the most common platforms, including BSD, Linux, macOS, Solaris, and Windows.

- The instructions, as well as the binaries, to install PostgreSQL can be found on the official web page (https://www.postgresql.org/download/).

My environment

- Windows 10 Professional
- Hyper-V
- Ubuntu 18.04.1 LTS
- PostgreSQL 11.1

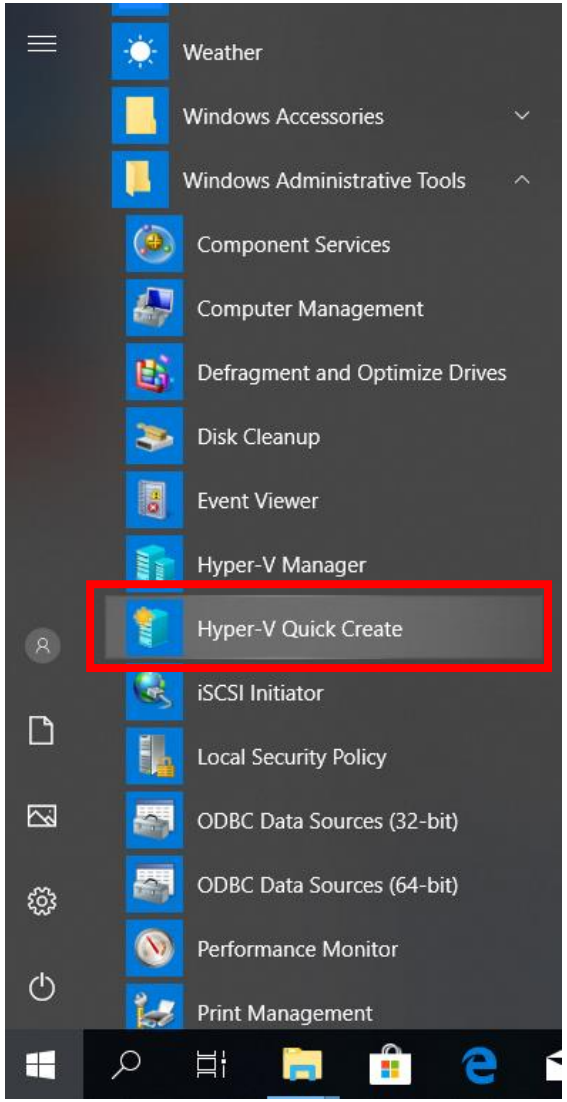
Enable Hyper-V

- **Check Requirements**
  - Windows 10 Enterprise, Pro, or Education
  - 64-bit Processor with Second Level Address Translation (SLAT).
  - CPU support for VM Monitor Mode Extension (VT-c on Intel CPUs).
  - Minimum of 4 GB memory.
- https://docs.microsoft.com/en-us/virtualization/hyper-v-on-windows/quick-start/enable-hyper-v

Create a Virtual Machine with Hyper-V

- https://docs.microsoft.com/en-us/virtualization/hyper-v-on-windows/quick-start/quick-create-virtual-machine

Windows 10 Fall Creators Update



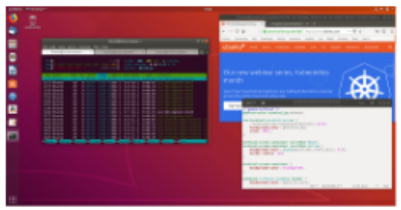
Create Virtual Machine

Select an operating system

- Windows 10 dev environment
- Ubuntu 18.04.1 LTS
- MSIX Packaging Tool Environment
- Local installation source

Ubuntu 18.04.1 LTS

Canonical Group Ltd



Ubuntu is used by thousands of development teams around the world because of its versatility, reliability and extensive developer libraries.

This LTS release comes with five years of support meaning that you can be assured of secure and dependable operating system giving you the fastest route from development to deployment on desktop, devices, server, cloud and IoT edge.

Ubuntu is free and will always be, and you have the option to get support and Landscape from Canonical. See https://www.ubuntu.com/legal for terms and conditions.

License https://www.ubuntu.com/licensing

Bionic Beaver

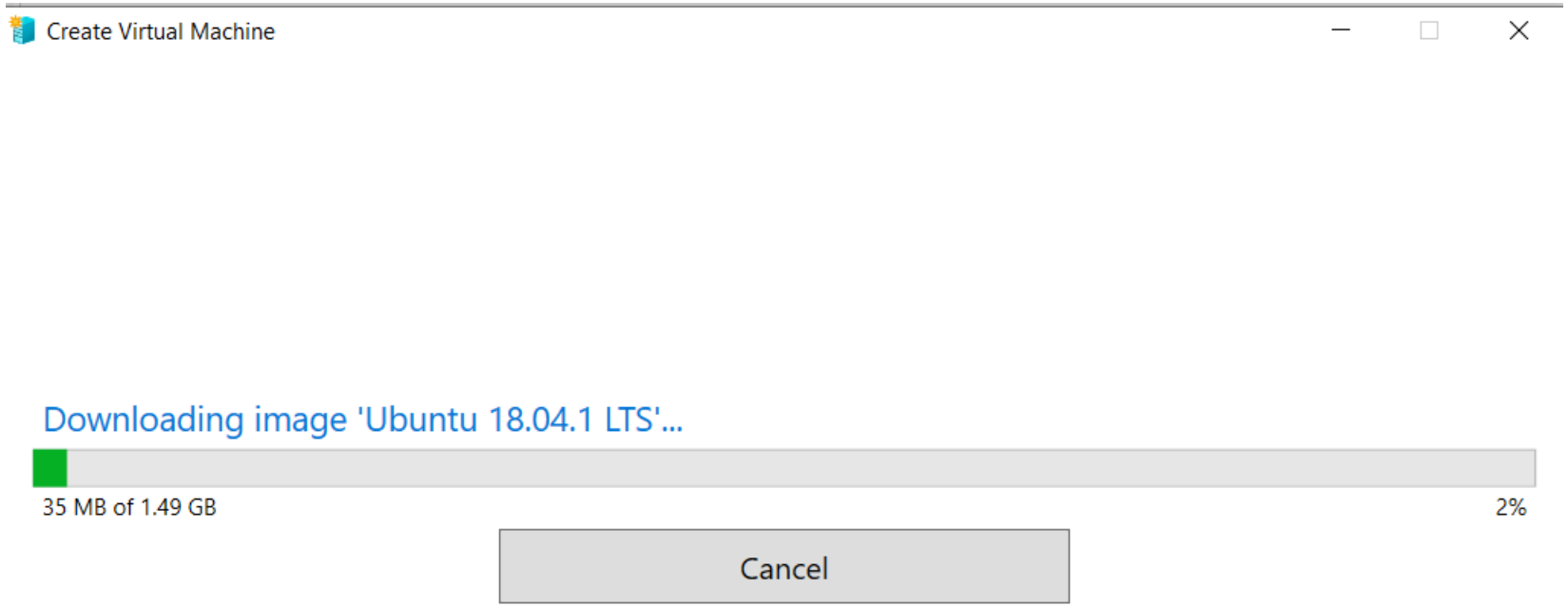
18.04.1 LTS

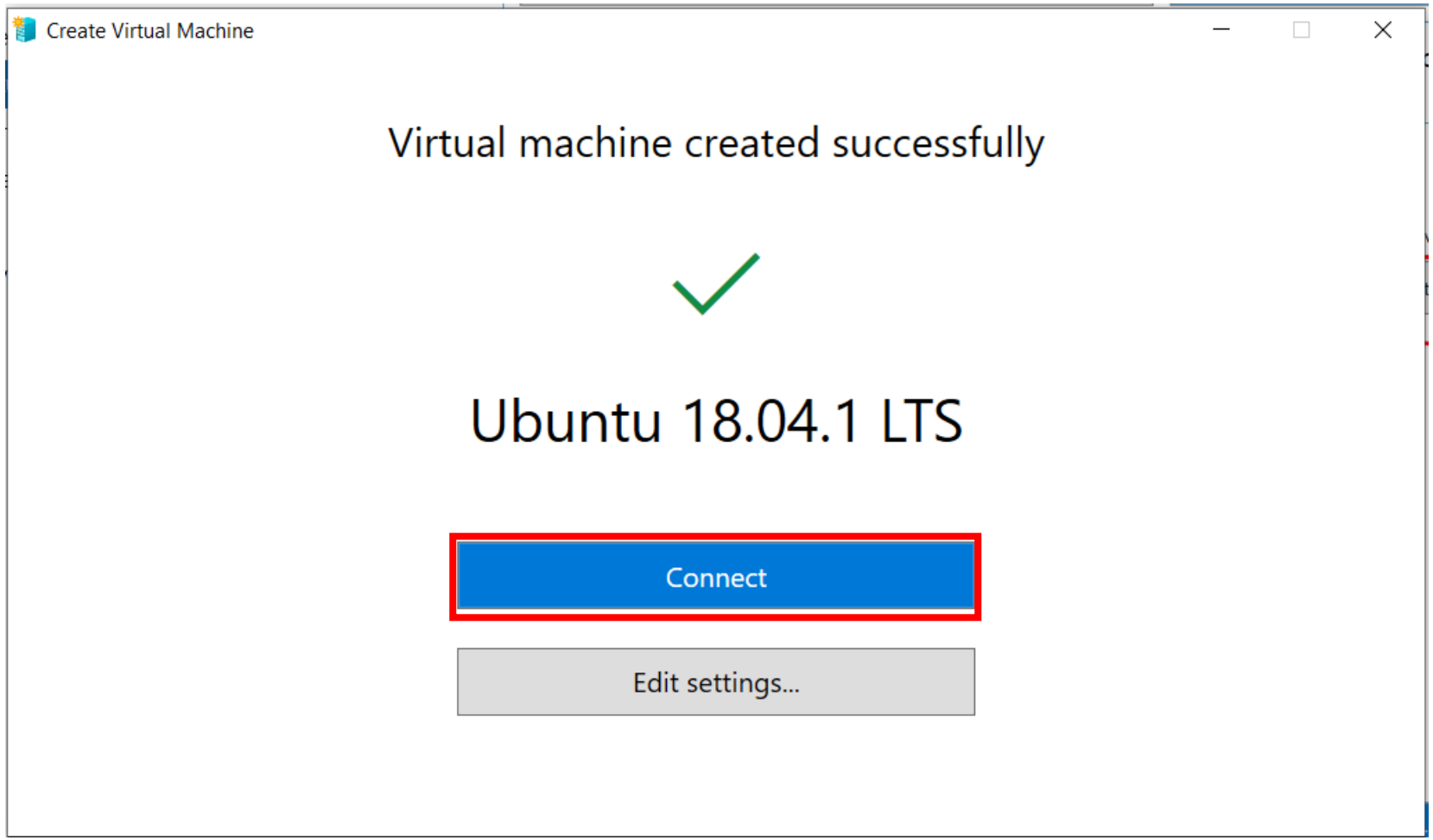
Version 18.04.1 LTS

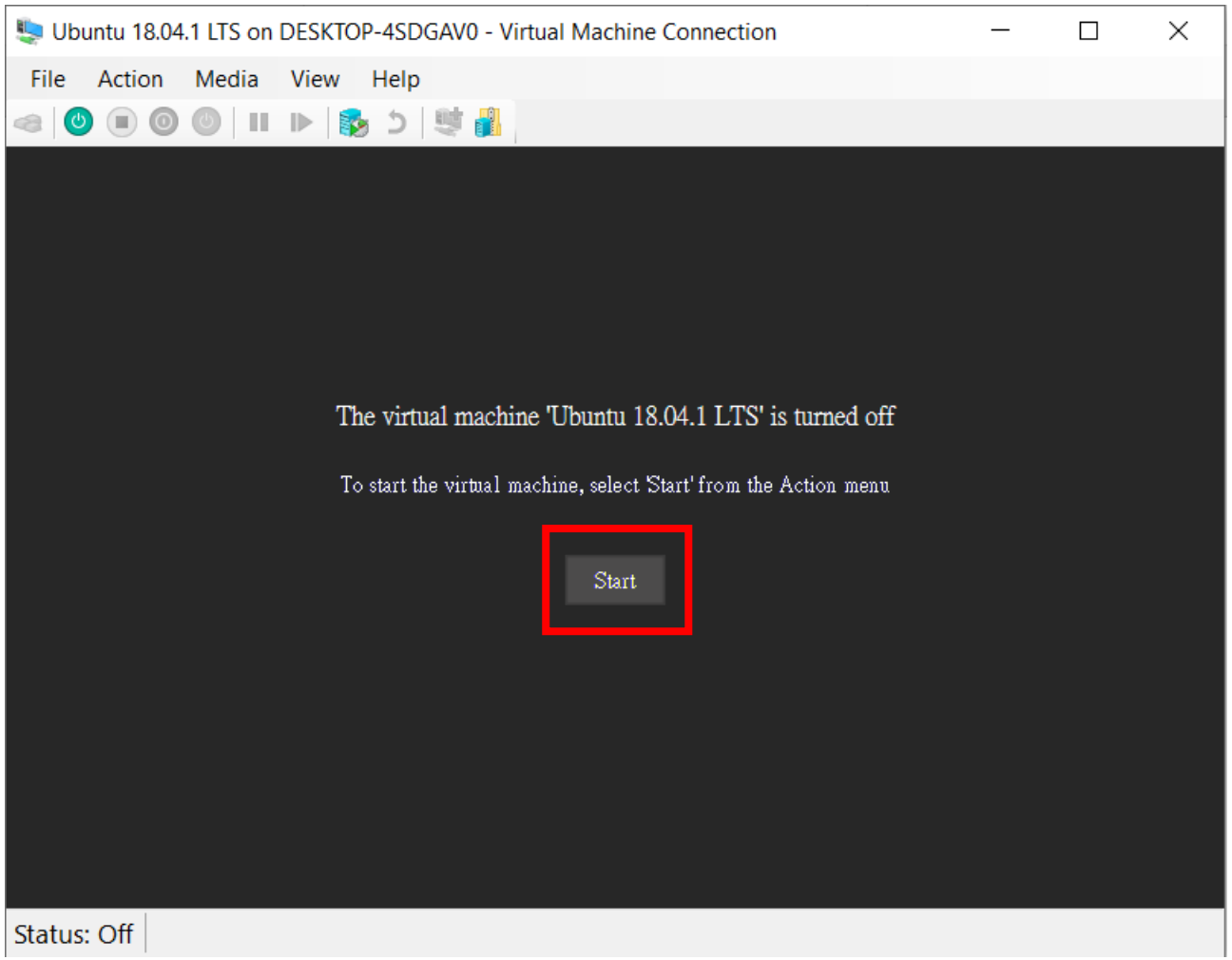
More options

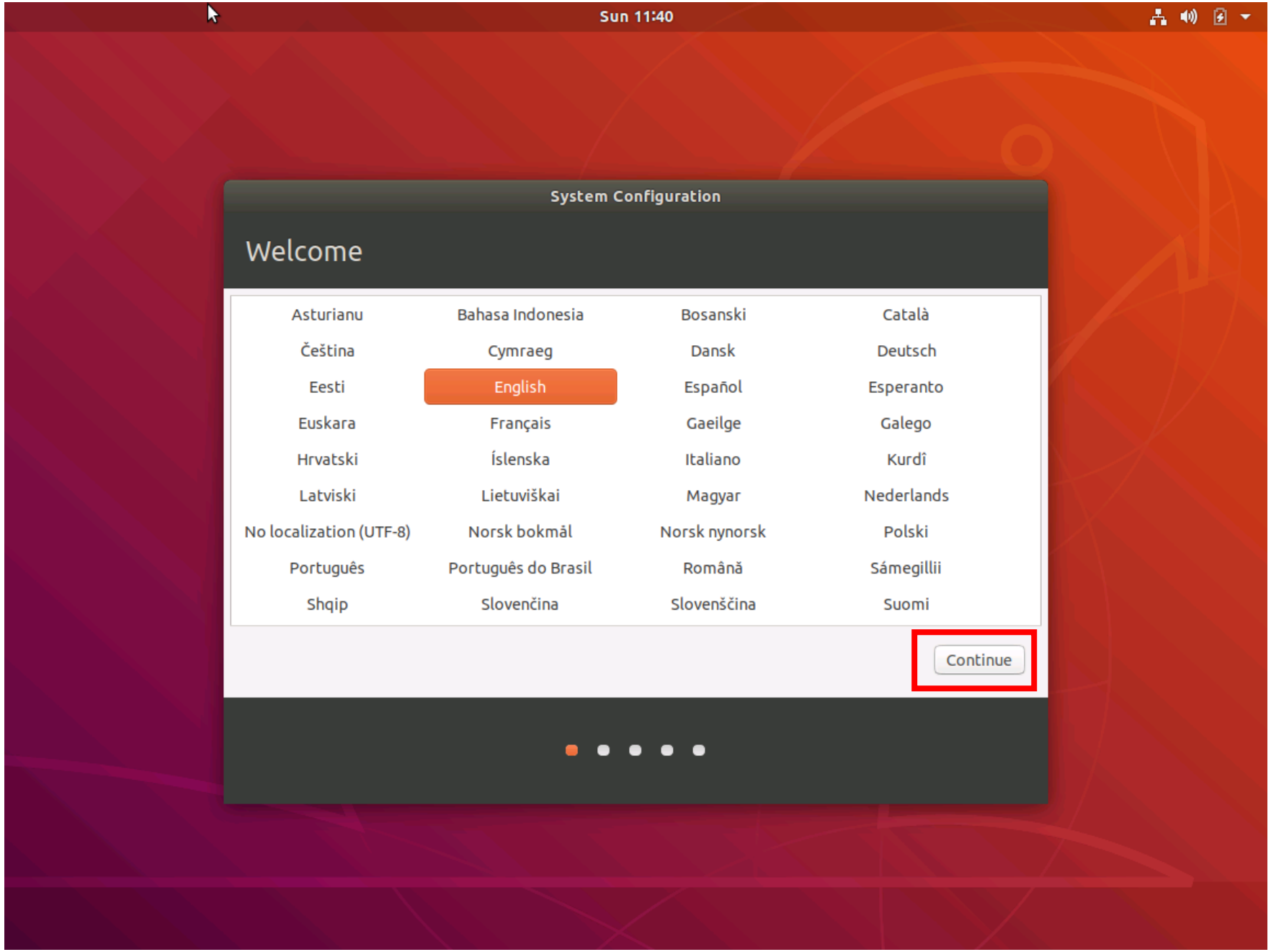
Close

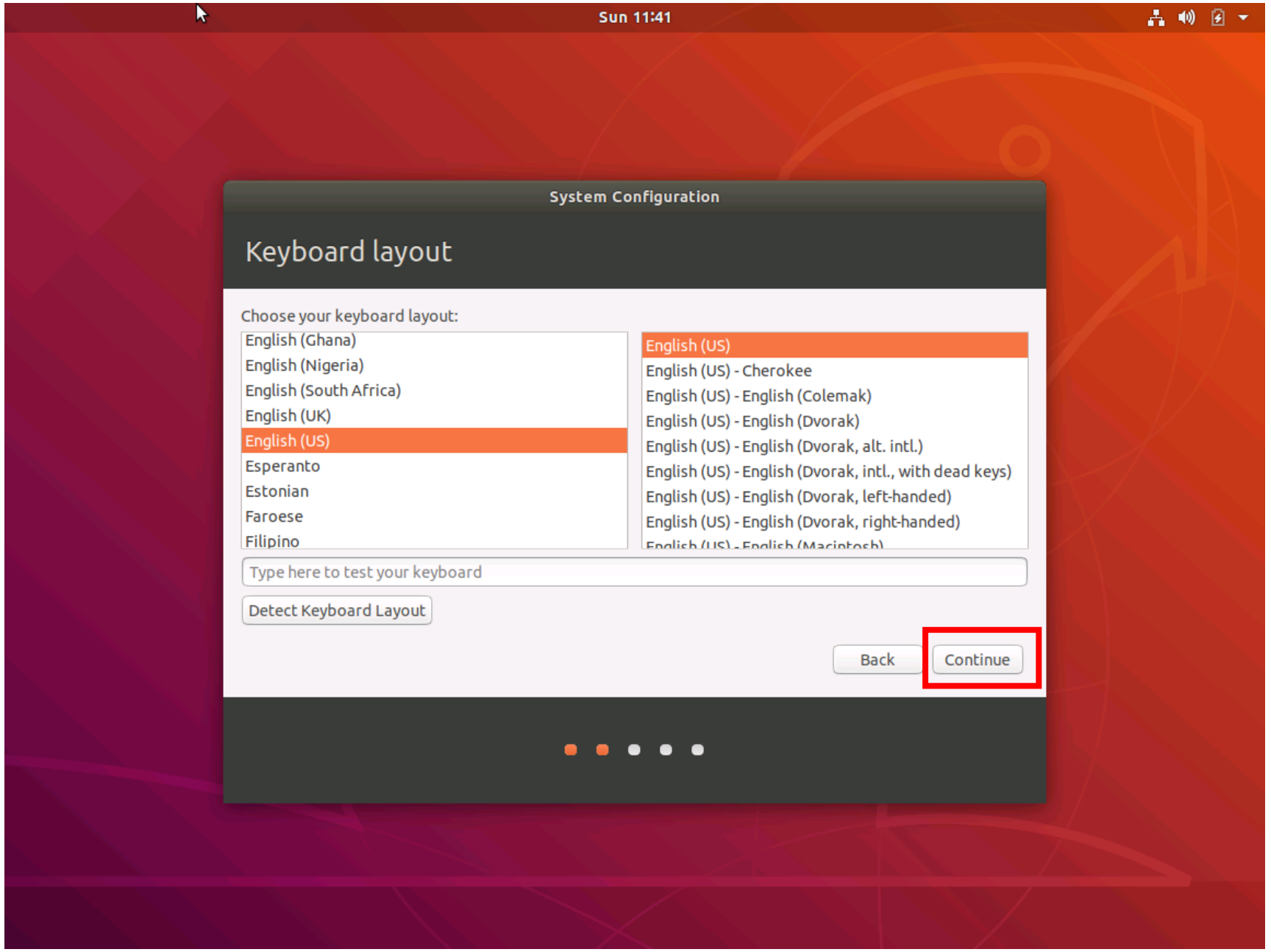
Create Virtual Machine

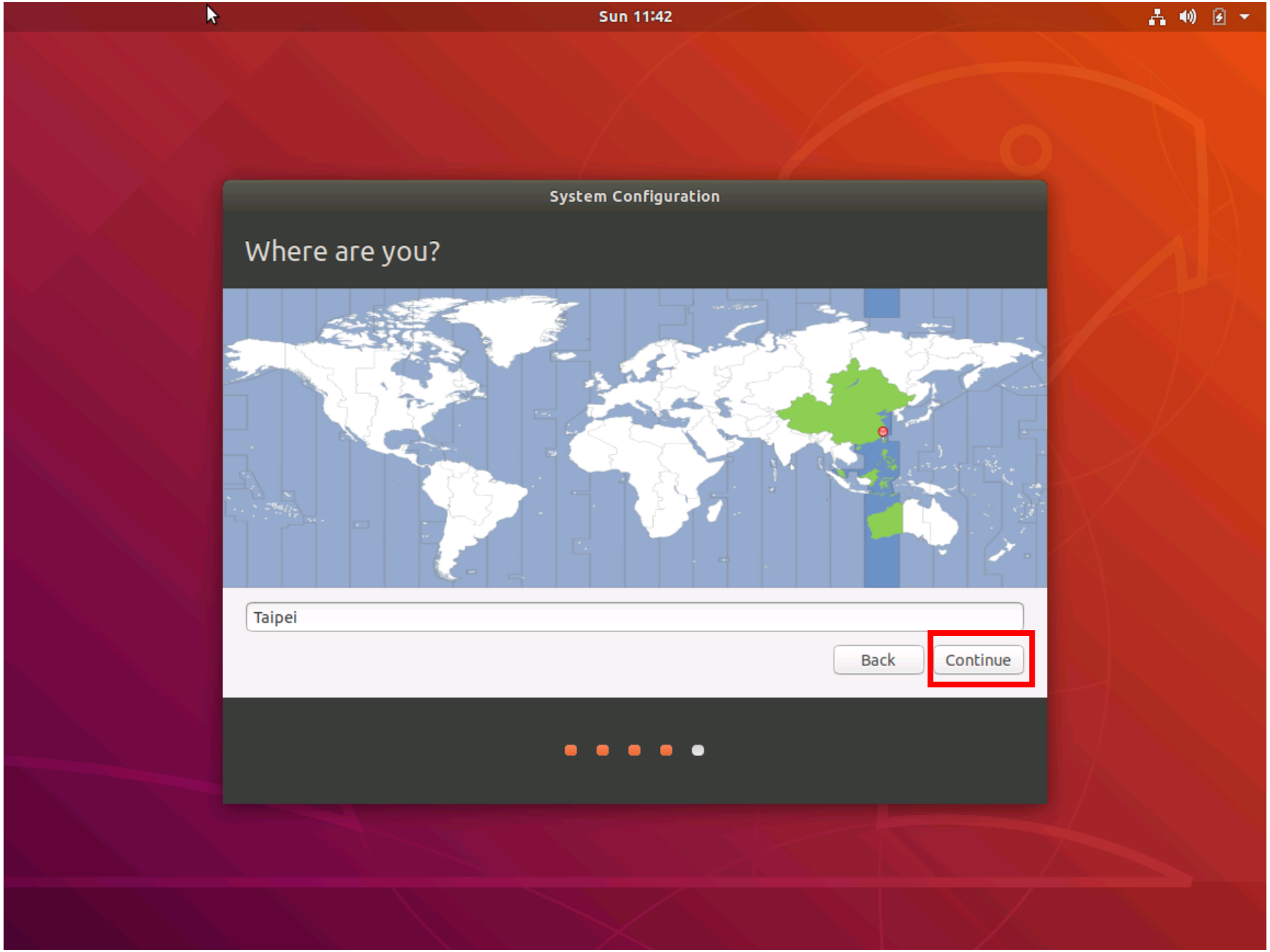

Create Virtual Machine
Downloading image 'Ubuntu 18.04.1 LTS'...
35 MB of 1.49 GB
2%
Cancel

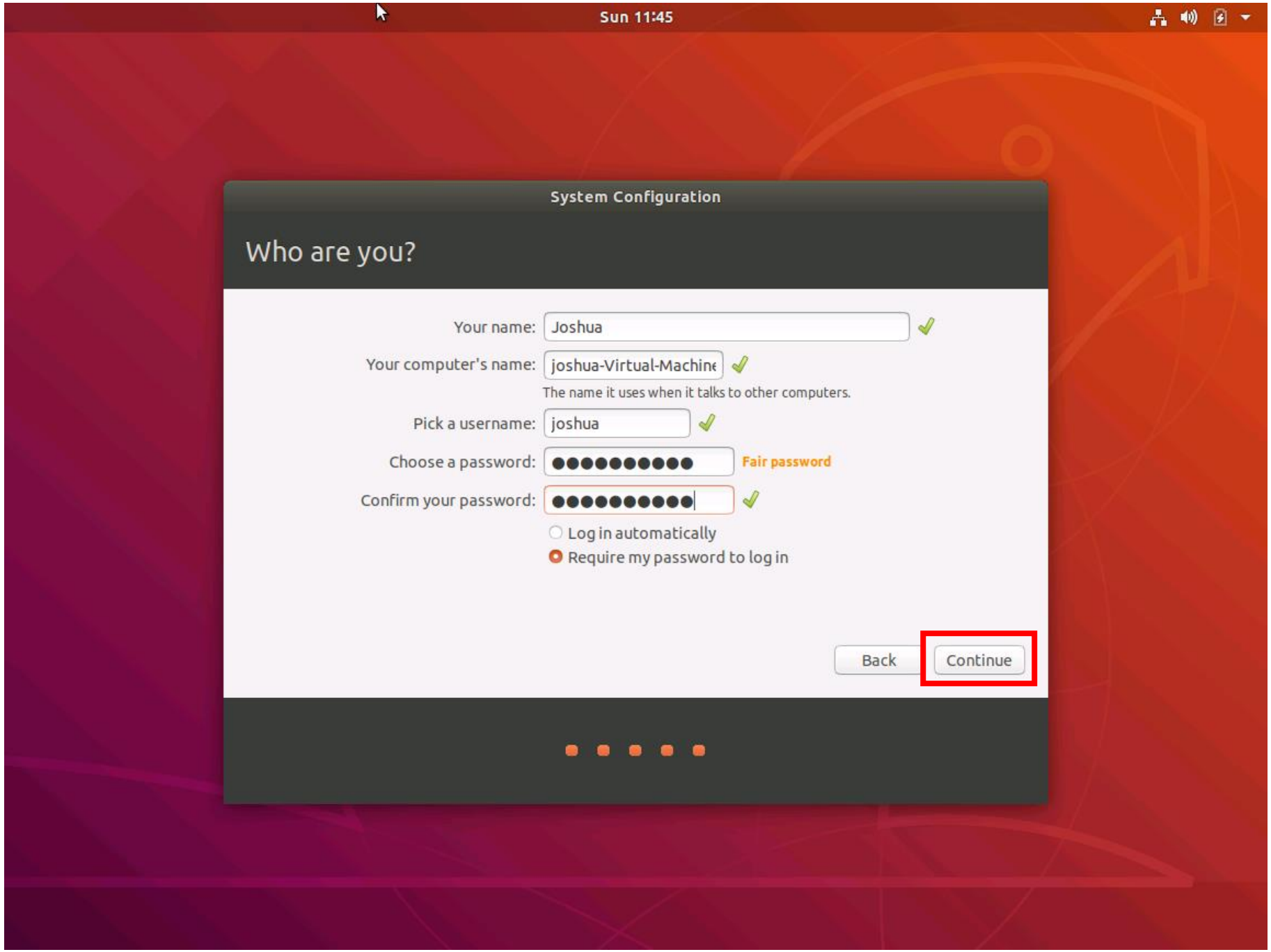

Create Virtual Machine
Virtual machine created successfully
Ubuntu 18.04.1 LTS
Connect
Edit settings...

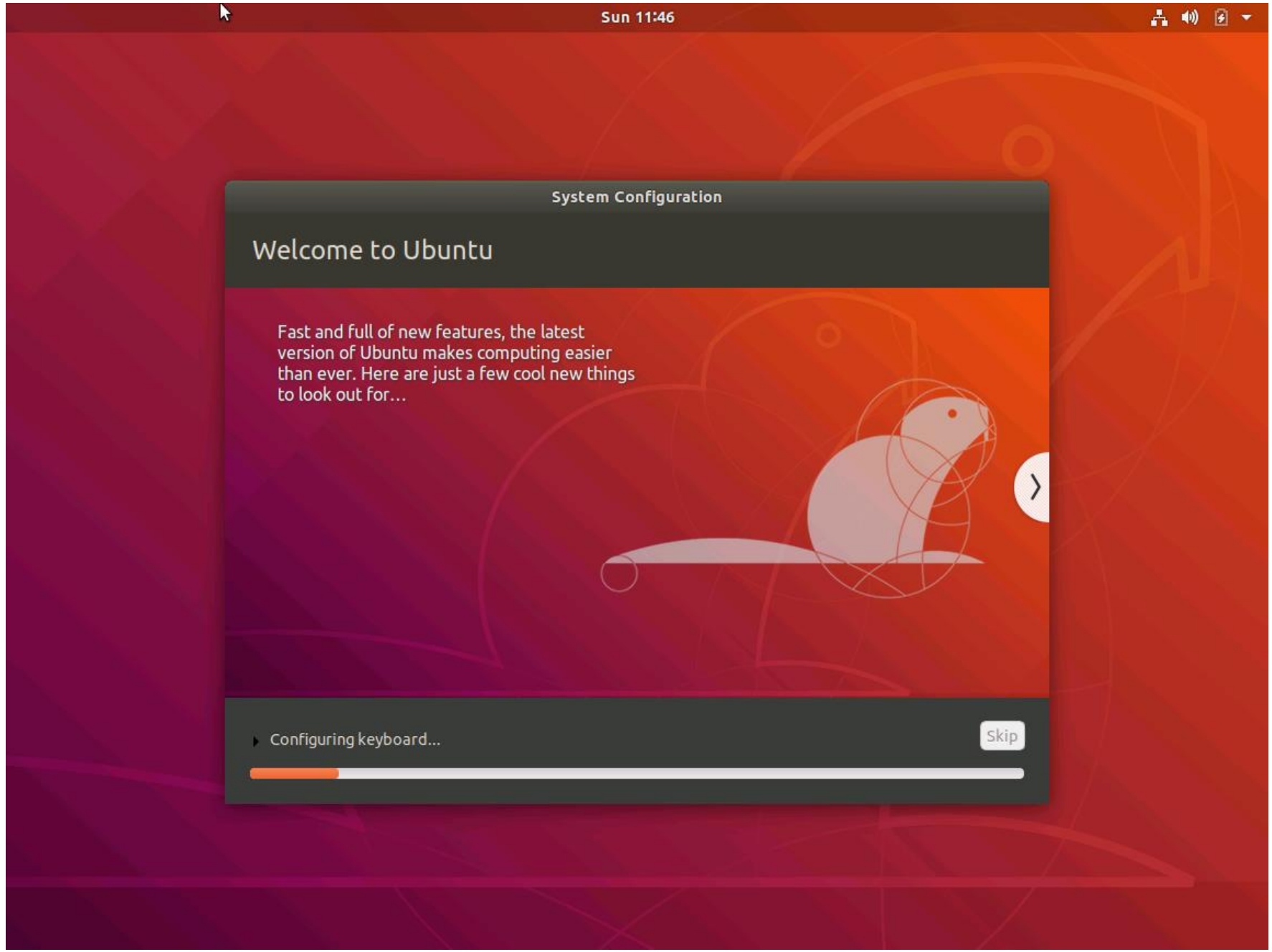

Ubuntu 18.04.1 LTS on DESKTOP-4SDGAV0 - Virtual Machine Connection
File
Action
Media
View
Help
The virtual machine 'Ubuntu 18.04.1 LTS' is turned off
To start the virtual machine, select 'Start' from the Action menu
Start
Status: Off


Sun 11:40
System Configuration
Welcome
Asturianu
Bahasa Indonesia
Bosanski
Català
Čeština
Cymraeg
Dansk
Deutsch
Eesti
English
Español
Esperanto
Euskara
Français
Gaeilge
Galego
Hrvatski
Íslenska
Italiano
Kurdî
Latviski
Lietuviškai
Magyar
Nederlands
No localization (UTF-8)
Norsk bokmål
Norsk nynorsk
Polski
Português
Português do Brasil
Română
Sámegillii
Shqip
Slovenčina
Slovenščina
Suomi
Continue

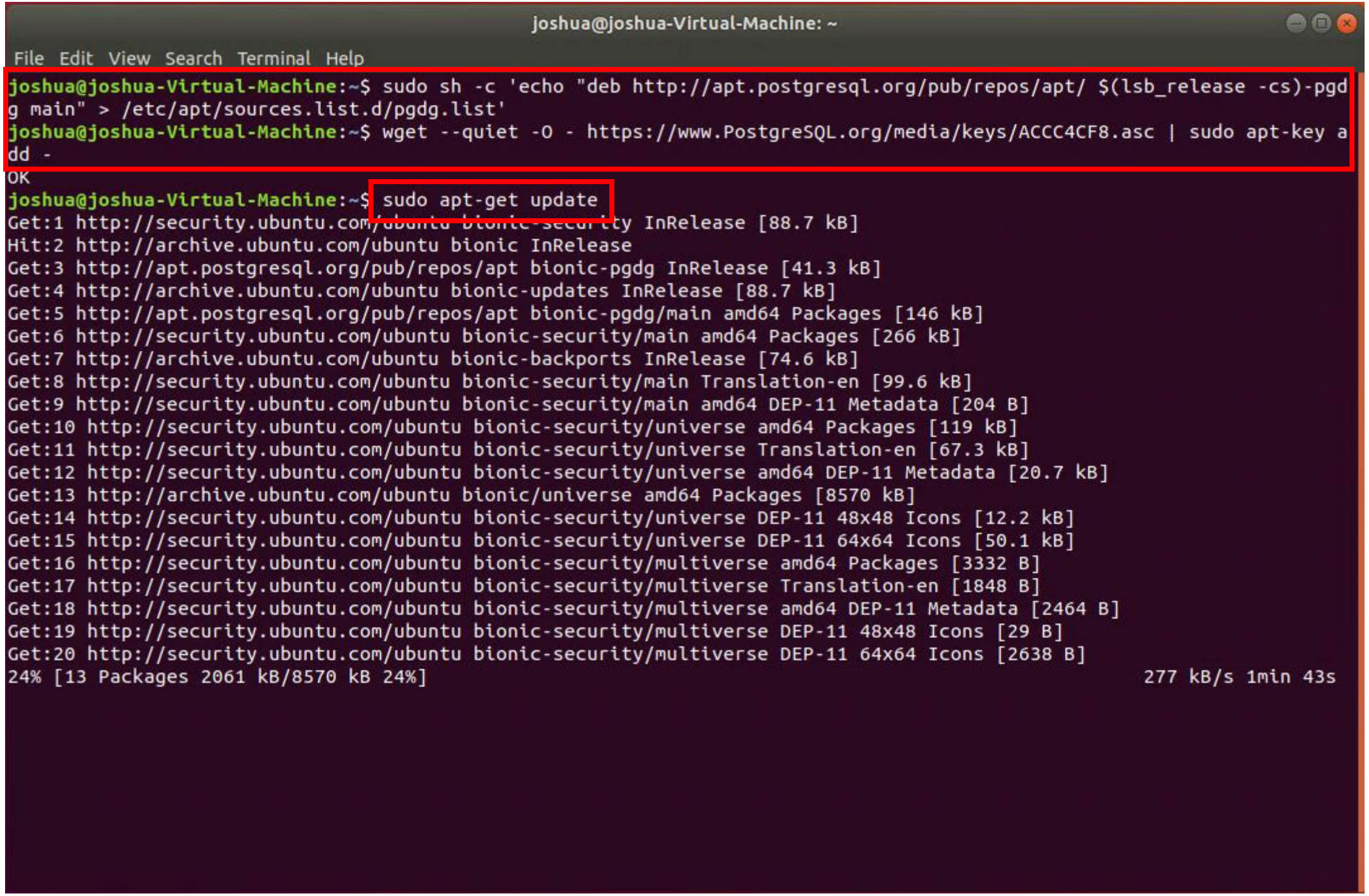

Sun 11:41
System Configuration
Keyboard layout
Choose your keyboard layout:
English (Ghana)
English (Nigeria)
English (South Africa)
English (UK)
English (US)
Esperanto
Estonian
Faroese
Filipino
English (US)
English (US) - Cherokee
English (US) - English (Colemak)
English (US) - English (Dvorak)
English (US) - English (Dvorak, alt. intl.)
English (US) - English (Dvorak, intl., with dead keys)
English (US) - English (Dvorak, left-handed)
English (US) - English (Dvorak, right-handed)
Type here to test your keyboard
Detect Keyboard Layout
Back
Continue


Sun 11:42
System Configuration
Where are you?
Taipei
Back
Continue

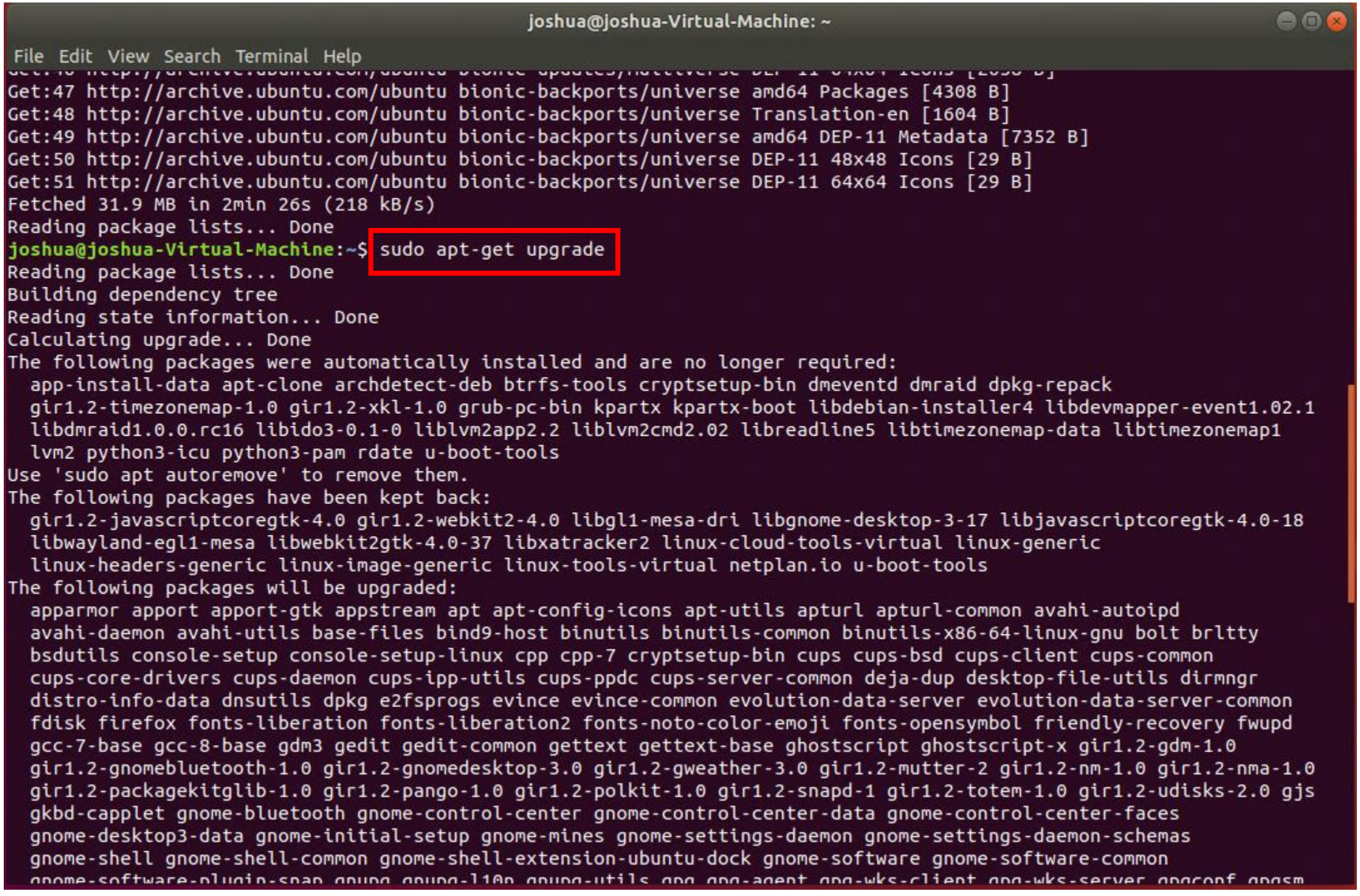

Sun 11:45
System Configuration
Who are you?
Your name:
Joshua
Your computer's name:
joshua-Virtual-Machine
The name it uses when it talks to other computers.
Pick a username:
joshua
Choose a password:
Fair password
Confirm your password:
Log in automatically
Require my password to log in
Back
Continue

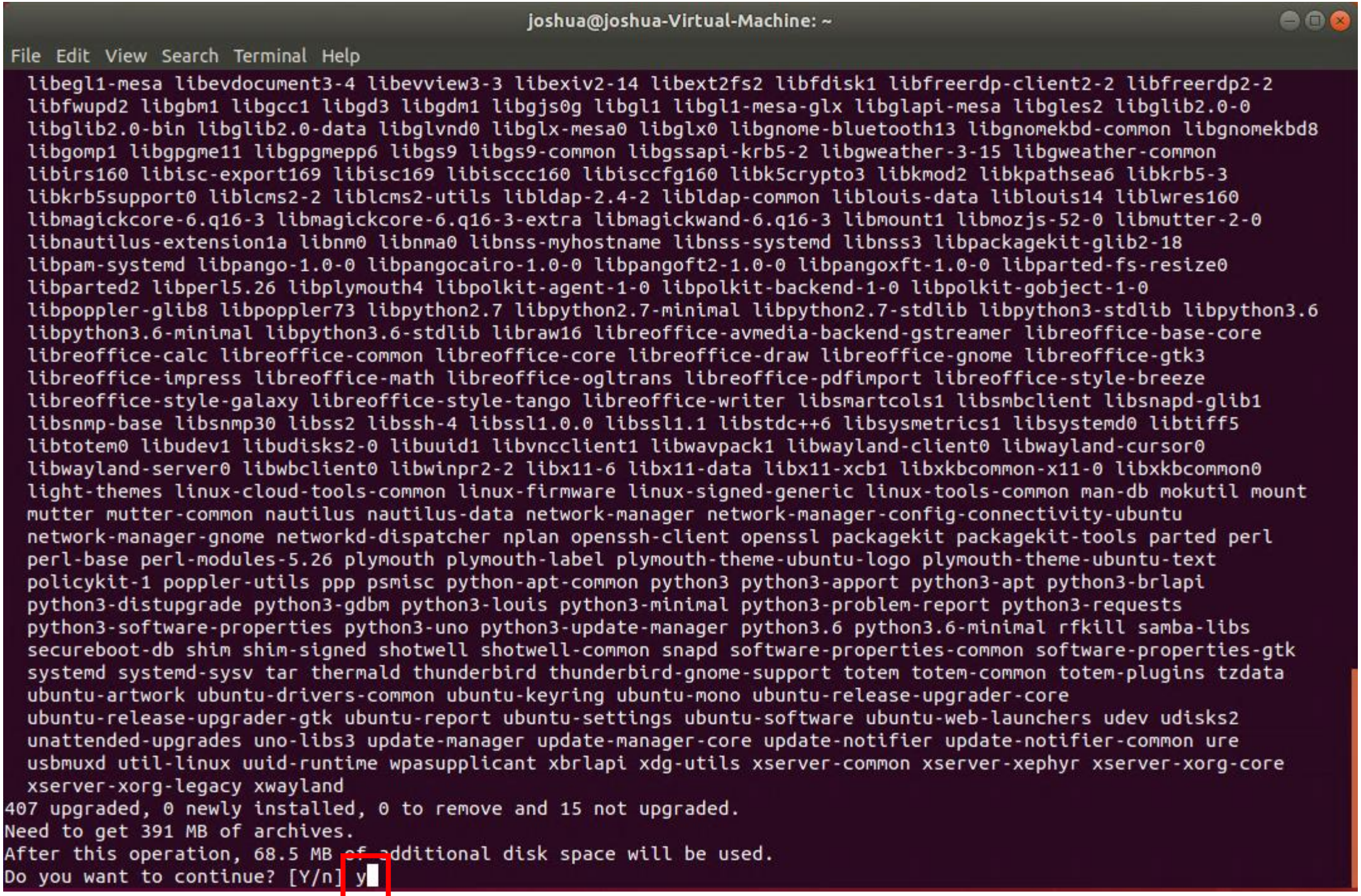

Sun 11:46
System Configuration
Welcome to Ubuntu
Fast and full of new features, the latest version of Ubuntu makes computing easier than ever. Here are just a few cool new things to look out for…
Configuring keyboard...
Skip

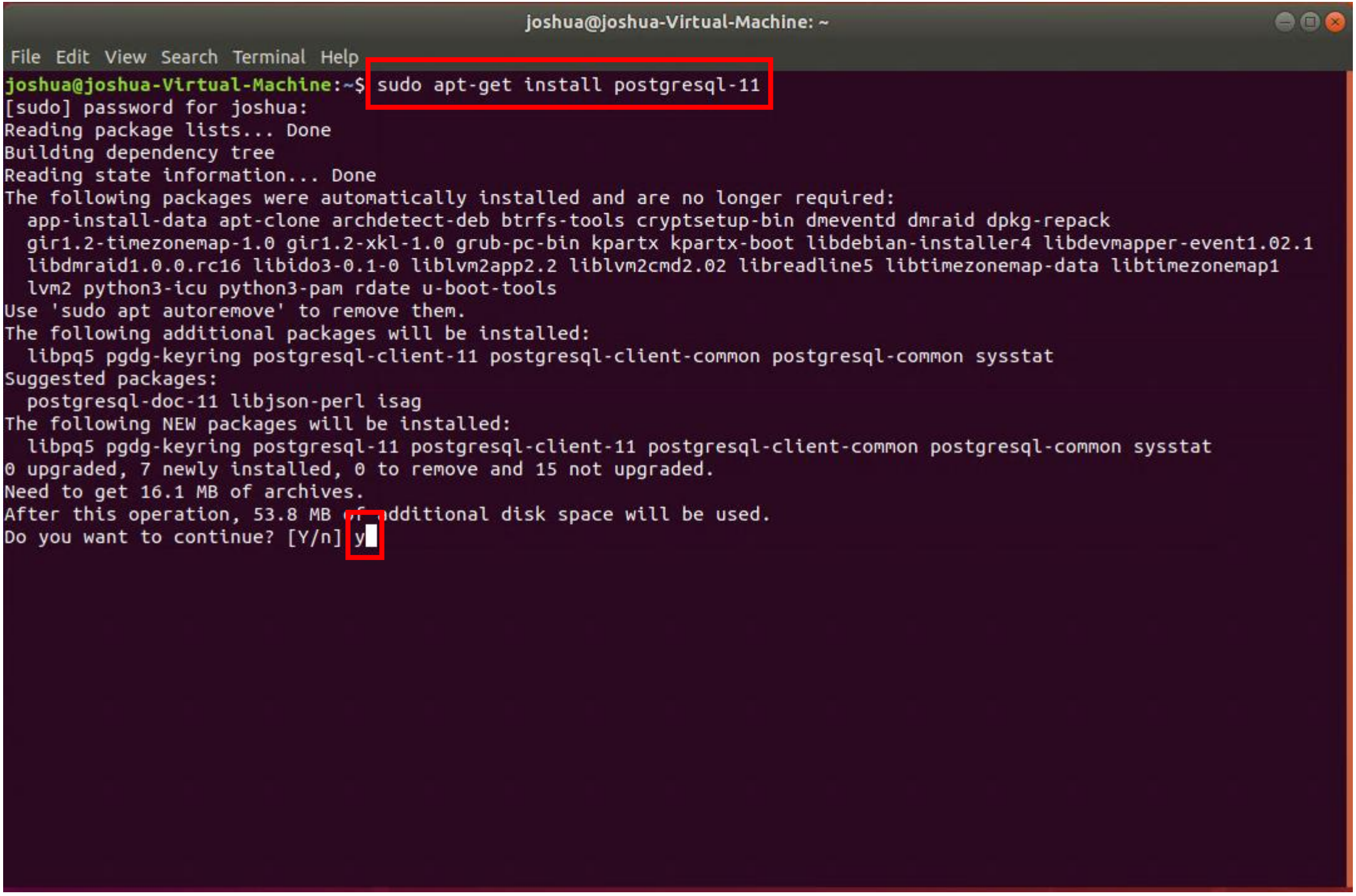
- **Advanced Package Tool (APT)** is used to handle the installation and removal of software on Debian and Debian-based distributions, such as the Ubuntu operating system.
- Recent PostgreSQL binaries might not yet be integrated with the official Debian and Ubuntu repositories.
- To set up the PostgreSQL `apt` repository on Debian or Ubuntu, execute the following:
  - `sudo sh -c 'echo "deb http://apt.postgresql.org/pub/repos/apt/ $(lsb_release -cs)-pgdg main" > /etc/apt/sources.list.d/pgdg.list'`
  - `wget --quiet -O - https://www.PostgreSQL.org/media/keys/ACCC4CF8.asc | sudo apt-key add -`
  - `sudo apt-get update`

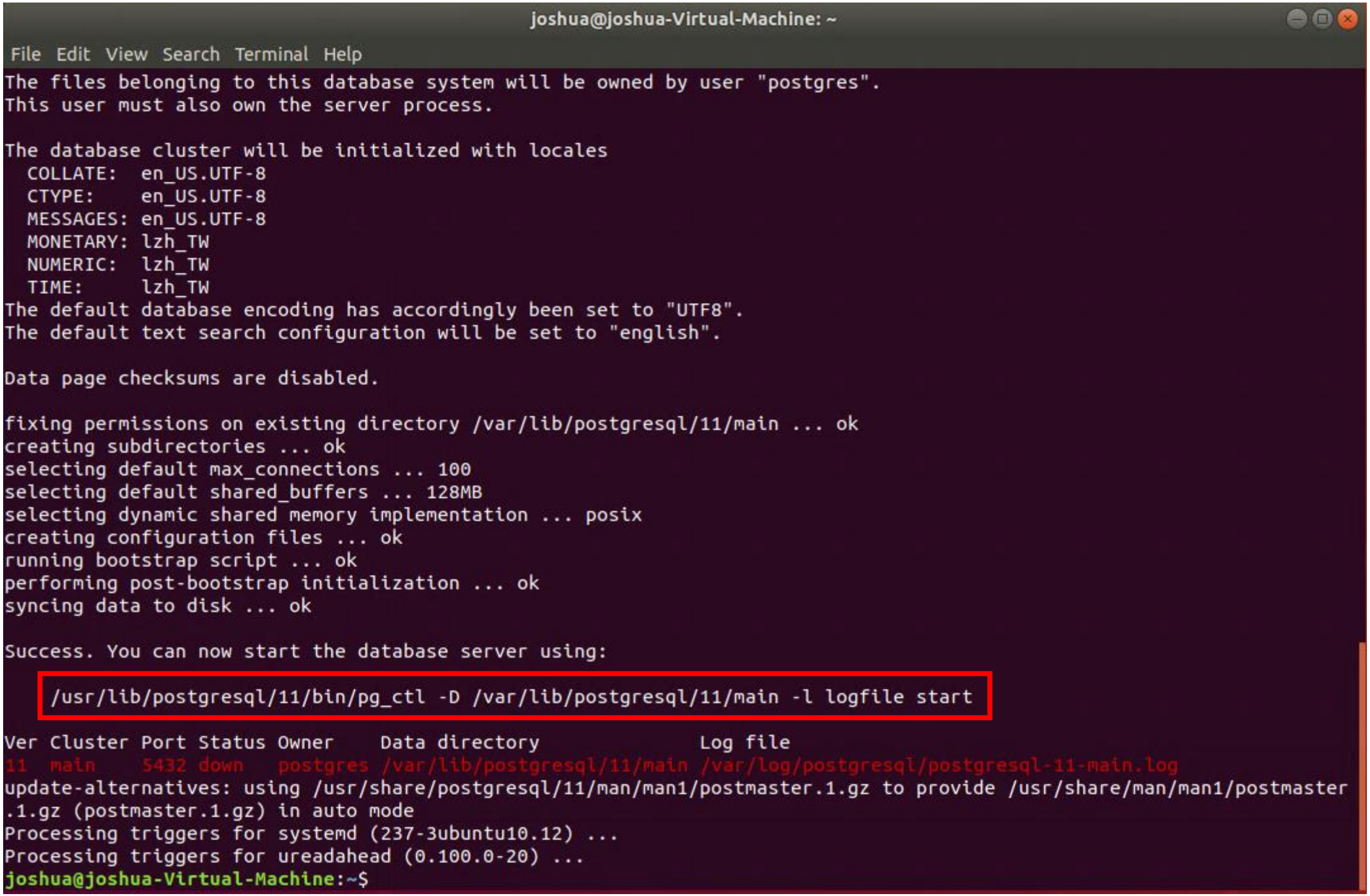

joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
joshua@joshua-Virtual-Machine:~$ sudo sh -c 'echo "deb http://apt.postgresql.org/pub/repos/apt/ $(lsb_release -cs)-pgdg main" > /etc/apt/sources.list.d/pgdg.list'
joshua@joshua-Virtual-Machine:~$ wget --quiet -O - https://www.PostgreSQL.org/media/keys/ACCC4CF8.asc | sudo apt-key add -
OK
joshua@joshua-Virtual-Machine:~$ sudo apt-get update
Get:1 http://security.ubuntu.com/ubuntu bionic-security InRelease [88.7 kB]
Hit:2 http://archive.ubuntu.com/ubuntu bionic InRelease
Get:3 http://apt.postgresql.org/pub/repos/apt bionic-pgdg InRelease [41.3 kB]
Get:4 http://archive.ubuntu.com/ubuntu bionic-updates InRelease [88.7 kB]
Get:5 http://apt.postgresql.org/pub/repos/apt bionic-pgdg/main amd64 Packages [146 kB]
Get:6 http://security.ubuntu.com/ubuntu bionic-security/main amd64 Packages [266 kB]
Get:7 http://archive.ubuntu.com/ubuntu bionic-backports InRelease [74.6 kB]
Get:8 http://security.ubuntu.com/ubuntu bionic-security/main Translation-en [99.6 kB]
Get:9 http://security.ubuntu.com/ubuntu bionic-security/main amd64 DEP-11 Metadata [204 B]
Get:10 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 Packages [119 kB]
Get:11 http://security.ubuntu.com/ubuntu bionic-security/universe Translation-en [67.3 kB]
Get:12 http://security.ubuntu.com/ubuntu bionic-security/universe amd64 DEP-11 Metadata [20.7 kB]
Get:13 http://archive.ubuntu.com/ubuntu bionic/universe amd64 Packages [8570 kB]
Get:14 http://security.ubuntu.com/ubuntu bionic-security/universe DEP-11 48x48 Icons [12.2 kB]
Get:15 http://security.ubuntu.com/ubuntu bionic-security/universe DEP-11 64x64 Icons [50.1 kB]
Get:16 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 Packages [3332 B]
Get:17 http://security.ubuntu.com/ubuntu bionic-security/multiverse Translation-en [1848 B]
Get:18 http://security.ubuntu.com/ubuntu bionic-security/multiverse amd64 DEP-11 Metadata [2464 B]
Get:19 http://security.ubuntu.com/ubuntu bionic-security/multiverse DEP-11 48x48 Icons [29 B]
Get:20 http://security.ubuntu.com/ubuntu bionic-security/multiverse DEP-11 64x64 Icons [2638 B]
24% [13 Packages 2061 kB/8570 kB 24%] 277 kB/s 1min 43s

- After adding a new apt repository, it's good to upgrade your system as follows:
  - `sudo apt-get upgrade`


joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
Get:47 http://archive.ubuntu.com/ubuntu bionic-backports/universe amd64 Packages [4308 B]
Get:48 http://archive.ubuntu.com/ubuntu bionic-backports/universe Translation-en [1604 B]
Get:49 http://archive.ubuntu.com/ubuntu bionic-backports/universe amd64 DEP-11 Metadata [7352 B]
Get:50 http://archive.ubuntu.com/ubuntu bionic-backports/universe DEP-11 48x48 Icons [29 B]
Get:51 http://archive.ubuntu.com/ubuntu bionic-backports/universe DEP-11 64x64 Icons [29 B]
Fetched 31.9 MB in 2min 26s (218 kB/s)
Reading package lists... Done
joshua@joshua-Virtual-Machine:~$ sudo apt-get upgrade
Reading package lists... Done
Building dependency tree
Reading state information... Done
Calculating upgrade... Done
The following packages were automatically installed and are no longer required:
app-install-data apt-clone archdetect-deb btrfs-tools cryptsetup-bin dmeventd dmraid dpkg-repack
gir1.2-timezonemap-1.0 gir1.2-xkl-1.0 grub-pc-bin kpartx kpartx-boot libdebian-installer4 libdevmapper-event1.02.1
libdmraid1.0.0.rc16 libido3-0.1-0 liblvm2app2.2 liblvm2cmd2.02 libreadline5 libtimezonemap-data libtimezonemap1
lvm2 python3-icu python3-pam rdate u-boot-tools
Use 'sudo apt autoremove' to remove them.
The following packages have been kept back:
gir1.2-javascriptcoregtk-4.0 gir1.2-webkit2-4.0 libgl1-mesa-dri libgnome-desktop-3-17 libjavascriptcoregtk-4.0-18
libwayland-egl1-mesa libwebkit2gtk-4.0-37 libxatracker2 linux-cloud-tools-virtual linux-generic
linux-headers-generic linux-image-generic linux-tools-virtual netplan.io u-boot-tools
The following packages will be upgraded:
apparmor apport apport-gtk appstream apt apt-config-icons apt-utils apturl apturl-common avahi-autoipd
avahi-daemon avahi-utils base-files bind9-host binutils binutils-common binutils-x86-64-linux-gnu bolt brltty
bsdutils console-setup console-setup-linux cpp cpp-7 cryptsetup-bin cups cups-bsd cups-client cups-common
cups-core-drivers cups-daemon cups-ipp-utils cups-ppdc cups-server-common deja-dup desktop-file-utils dirmngr
distro-info-data dnsutils dpkg e2fsprogs evince evince-common evolution-data-server evolution-data-server-common
fdisk firefox fonts-liberation fonts-liberation2 fonts-noto-color-emoji fonts-opensymbol friendly-recovery fwupd
gcc-7-base gcc-8-base gdm3 gedit gedit-common gettext gettext-base ghostscript ghostscript-x gir1.2-gdm-1.0
gir1.2-gnomebluetooth-1.0 gir1.2-gnomedesktop-3.0 gir1.2-gweather-3.0 gir1.2-mutter-2 gir1.2-nm-1.0 gir1.2-nma-1.0
gir1.2-packagekitglib-1.0 gir1.2-pango-1.0 gir1.2-polkit-1.0 gir1.2-snapd-1 gir1.2-totem-1.0 gir1.2-udisks-2.0 gjs
gkbd-capplet gnome-bluetooth gnome-control-center gnome-control-center-data gnome-control-center-faces
gnome-desktop3-data gnome-initial-setup gnome-mines gnome-settings-daemon gnome-settings-daemon-schemas
gnome-shell gnome-shell-common gnome-shell-extension-ubuntu-dock gnome-software gnome-software-common

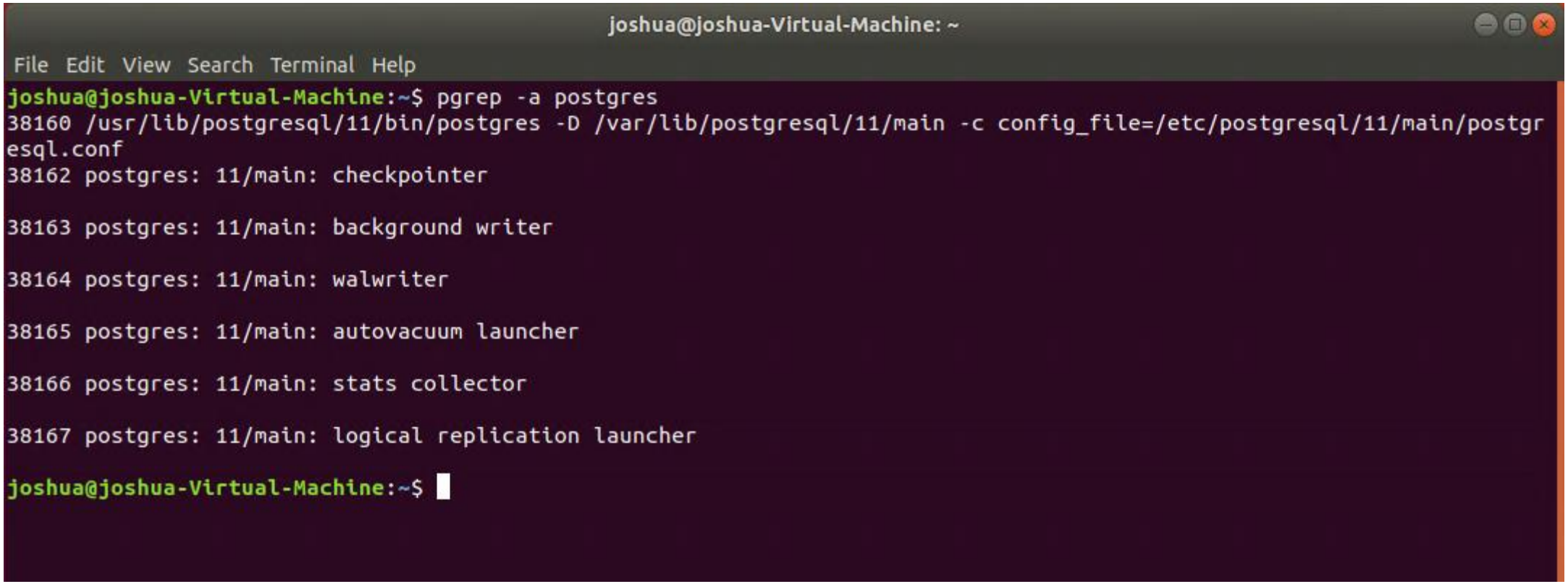

joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
libegl1-mesa libevdocument3-4 libevview3-3 libexiv2-14 libext2fs2 libfdisk1 libfreerdp-client2-2 libfreerdp2-2
libfwupd2 libgbm1 libgcc1 libgd3 libgdm1 libgjs0g libgl1 libgl1-mesa-glx libglapi-mesa libgles2 libglib2.0-0
libglib2.0-bin libglib2.0-data libglvnd0 libglx-mesa0 libglx0 libgnome-bluetooth13 libgnomekbd-common libgnomekbd8
libgomp1 libgpgme11 libgpgmepp6 libgs9 libgs9-common libgssapi-krb5-2 libgweather-3-15 libgweather-common
libirs160 libisc-export169 libisc169 libisccc160 libisccfg160 libk5crypto3 libkmod2 libkpathsea6 libkrb5-3
libkrb5support0 liblcms2-2 liblcms2-utils libldap-2.4-2 libldap-common liblouis-data liblouis14 liblwres160
libmagickcore-6.q16-3 libmagickcore-6.q16-3-extra libmagickwand-6.q16-3 libmount1 libmozjs-52-0 libmutter-2-0
libnautilus-extension1a libnm0 libnma0 libnss-myhostname libnss-systemd libnss3 libpackagekit-glib2-18
libpam-systemd libpango-1.0-0 libpangocairo-1.0-0 libpangoft2-1.0-0 libpangoxft-1.0-0 libparted-fs-resize0
libparted2 libperl5.26 libplymouth4 libpolkit-agent-1-0 libpolkit-backend-1-0 libpolkit-gobject-1-0
libpoppler-glib8 libpoppler73 libpython2.7 libpython2.7-minimal libpython2.7-stdlib libpython3-stdlib libpython3.6
libpython3.6-minimal libpython3.6-stdlib libraw16 libreoffice-avmedia-backend-gstreamer libreoffice-base-core
libreoffice-calc libreoffice-common libreoffice-core libreoffice-draw libreoffice-gnome libreoffice-gtk3
libreoffice-impress libreoffice-math libreoffice-ogltrans libreoffice-pdfimport libreoffice-style-breeze
libreoffice-style-galaxy libreoffice-style-tango libreoffice-writer libsmartcols1 libsmbclient libsnapd-glib1
libsnmp-base libsnmp30 libss2 libssh-4 libssl1.0.0 libssl1.1 libstdc++6 libsysmetrics1 libsystemd0 libtiff5
libtotem0 libudev1 libudisks2-0 libuuid1 libvncclient1 libwavpack1 libwayland-client0 libwayland-cursor0
libwayland-server0 libwbclient0 libwinpr2-2 libx11-6 libx11-data libx11-xcb1 libxkbcommon-x11-0 libxkbcommon0
light-themes linux-cloud-tools-common linux-firmware linux-signed-generic linux-tools-common man-db mokutil mount
mutter mutter-common nautilus nautilus-data network-manager network-manager-config-connectivity-ubuntu
network-manager-gnome networkd-dispatcher nplan openssh-client openssl packagekit packagekit-tools parted perl
perl-base perl-modules-5.26 plymouth plymouth-label plymouth-theme-ubuntu-logo plymouth-theme-ubuntu-text
policykit-1 poppler-utils ppp psmisc python-apt-common python3 python3-apport python3-apt python3-brlapi
python3-distupgrade python3-gdbm python3-louis python3-minimal python3-problem-report python3-requests
python3-software-properties python3-uno python3-update-manager python3.6 python3.6-minimal rfkill samba-libs
secureboot-db shim shim-signed shotwell shotwell-common snapd software-properties-common software-properties-gtk
systemd systemd-sysv tar thermald thunderbird thunderbird-gnome-support totem totem-common totem-plugins tzdata
ubuntu-artwork ubuntu-drivers-common ubuntu-keyring ubuntu-mono ubuntu-release-upgrader-core
ubuntu-release-upgrader-gtk ubuntu-report ubuntu-settings ubuntu-software ubuntu-web-launchers udev udisks2
unattended-upgrades uno-libs3 update-manager update-manager-core update-notifier update-notifier-common ure
usbmuxd util-linux uuid-runtime wpasupplicant xbrlapi xdg-utils xserver-common xserver-xephyr xserver-xorg-core
xserver-xorg-legacy xwayland
407 upgraded, 0 newly installed, 0 to remove and 15 not upgraded.
Need to get 391 MB of archives.
After this operation, 68.5 MB of additional disk space will be used.
Do you want to continue? [Y/n] y


joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
joshua@joshua-Virtual-Machine:~$ sudo apt-get install postgresql-11
[sudo] password for joshua:
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following packages were automatically installed and are no longer required:
app-install-data apt-clone archdetect-deb btrfs-tools cryptsetup-bin dmeventd dmraid dpkg-repack
gir1.2-timezonemap-1.0 gir1.2-xkl-1.0 grub-pc-bin kpartx kpartx-boot libdebian-installer4 libdevmapper-event1.02.1
libdmraid1.0.0.rc16 libido3-0.1-0 liblvm2app2.2 liblvm2cmd2.02 libreadline5 libtimezonemap-data libtimezonemap1
lvm2 python3-icu python3-pam rdate u-boot-tools
Use 'sudo apt autoremove' to remove them.
The following additional packages will be installed:
libpq5 pgdg-keyring postgresql-client-11 postgresql-client-common postgresql-common sysstat
Suggested packages:
postgresql-doc-11 libjson-perl isag
The following NEW packages will be installed:
libpq5 pgdg-keyring postgresql-11 postgresql-client-11 postgresql-client-common postgresql-common sysstat
0 upgraded, 7 newly installed, 0 to remove and 15 not upgraded.
Need to get 16.1 MB of archives.
After this operation, 53.8 MB
dditional disk space will be used.
Do you want to continue? [Y/n] y


joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
The files belonging to this database system will be owned by user "postgres".
This user must also own the server process.
The database cluster will be initialized with locales
COLLATE: en_US.UTF-8
CTYPE: en_US.UTF-8
MESSAGES: en_US.UTF-8
MONETARY: lzh_TW
NUMERIC: lzh_TW
TIME: lzh_TW
The default database encoding has accordingly been set to "UTF8".
The default text search configuration will be set to "english".
Data page checksums are disabled.
fixing permissions on existing directory /var/lib/postgresql/11/main ... ok
creating subdirectories ... ok
selecting default max_connections ... 100
selecting default shared_buffers ... 128MB
selecting dynamic shared memory implementation ... posix
creating configuration files ... ok
running bootstrap script ... ok
performing post-bootstrap initialization ... ok
syncing data to disk ... ok
Success. You can now start the database server using:
/usr/lib/postgresql/11/bin/pg_ctl -D /var/lib/postgresql/11/main -l logfile start
Ver Cluster Port Status Owner Data directory Log file
11 main 5432 down postgres /var/lib/postgresql/11/main /var/log/postgresql/postgresql-11-main.log
update-alternatives: using /usr/share/postgresql/11/man/man1/postmaster.1.gz to provide /usr/share/man/man1/postmaster.1.gz (postmaster.1.gz) in auto mode
Processing triggers for systemd (237-3ubuntu10.12) ...
Processing triggers for ureadahead (0.100.0-20) ...
joshua@joshua-Virtual-Machine:~$

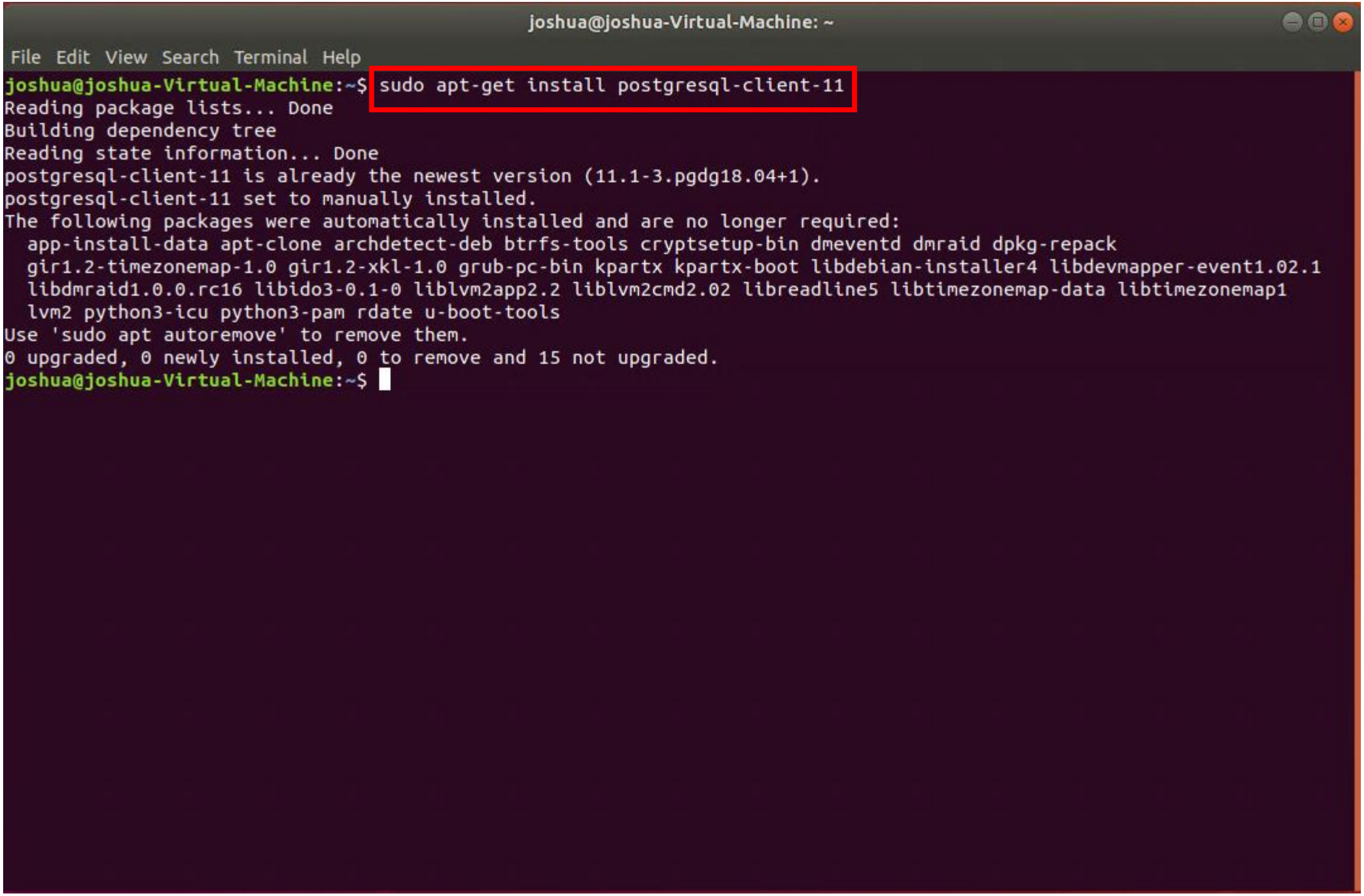
- PostgreSQL initializes a storage area on the hard disk called a database cluster.
- A database cluster is a collection of databases managed by a single instance of a running database server.
- This means that one can have more than one instance of PostgreSQL running on the same server by initializing several database clusters.
- These instances can be of different PostgreSQL server versions or the same version.

- To check the installation, `grep` the `postgres` processes, as follows:



- The preceding query shows the main server process with two options: the `-D` option specifies the database cluster, and the `-c` option specifies the configuration file.
- Also, it shows many utility processes, such as `autovacuum`, and statistics-collector processes.

- If you have a PostgreSQL server already installed and you need to interact with it, you need to install the postgresql-client software package.
- In order to do so, open a Terminal and execute the following command:
  - `sudo apt-get install postgresql-client-11`


joshua@joshua-Virtual-Machine: ~
File Edit View Search Terminal Help
joshua@joshua-Virtual-Machine:~$ sudo apt-get install postgresql-client-11
Reading package lists... Done
Building dependency tree
Reading state information... Done
postgresql-client-11 is already the newest version (11.1-3.pgdg18.04+1).
postgresql-client-11 set to manually installed.
The following packages were automatically installed and are no longer required:
app-install-data apt-clone archdetect-deb btrfs-tools cryptsetup-bin dmeventd dmraid dpkg-repack
gir1.2-timezonemap-1.0 gir1.2-xkl-1.0 grub-pc-bin kpartx kpartx-boot libdebian-installer4 libdevmapper-event1.02.1
libdmraid1.0.0.rc16 libido3-0.1-0 liblvm2app2.2 liblvm2cmd2.02 libreadline5 libtimezonemap-data libtimezonemap1
lvm2 python3-icu python3-pam rdate u-boot-tools
Use 'sudo apt autoremove' to remove them.
0 upgraded, 0 newly installed, 0 to remove and 15 not upgraded.
joshua@joshua-Virtual-Machine:~$

Basic Server Configuration

- In order to access the server, we need to understand the PostgreSQL authentication mechanism.
- On Linux systems, you can connect to PostgreSQL using a Unix-socket or TCP/IP protocol.
- Also, PostgreSQL supports many types of authentication methods.

- When a PostgreSQL server is installed, a new operating system user, as well as a database user, with the name `postgres` is created.
- This user can connect to the database server using peer authentication.
- The peer authentication gets the client's operating system username and uses it to access the databases that can be accessed.
- Peer authentication is supported only by local connections—connections that use Unix sockets.
- Peer authentication is supported by Linux distribution but not by Windows.

- Client authentication is controlled by a configuration file named `pg_hba.conf`, where `pg` stands for PostgreSQL and `hba` stands for host-based authentication.
- To take a look at peer authentication, let's display the content of `pg_hba.conf`:

```
joshua@joshua-Virtual-Machine:~$ sudo su
[sudo] password for joshua:
root@joshua-Virtual-Machine:/home/joshua# grep -v '^#' /etc/postgresql/11/main/pg_hba.conf|grep 'peer'
local   all             postgres                                peer
local   all             all                                     peer
local   replication     all                                     peer
root@joshua-Virtual-Machine:/home/joshua# exit
exit
joshua@joshua-Virtual-Machine:~$
```

- The `postgres` user can connect to all the databases using Unix-socket and the peer authentication method.

- To connect to the database servers using the `postgres` user, first we need to switch the operating system's current user to `postgres` and then invoke `psql`.

```
joshua@joshua-Virtual-Machine:~$ sudo -u postgres psql
psql (11.1 (Ubuntu 11.1-3.pgdg18.04+1))
Type "help" for help.

postgres=# SELECT version();
```

```
                                                 version

-------------------------------------------------------------------------------------------------------------
------------
 PostgreSQL 11.1 (Ubuntu 11.1-3.pgdg18.04+1) on x86_64-pc-linux-gnu, compiled by gcc (Ubuntu 7.3.0-27ubuntu1~18.04) 7.
3.0, 64-bit
(1 row)

(END)
```

```
joshua@joshua-Virtual-Machine:~$ sudo -u postgres psql
psql (11.1 (Ubuntu 11.1-3.pgdg18.04+1))
Type "help" for help.

postgres=# SELECT version();
postgres=# \q
joshua@joshua-Virtual-Machine:~$
```

- Prior to PostgreSQL 10, the PostgreSQL version number had three digits.
- Major releases occur roughly on an annual basis and usually change the internal format of the data.
  - This means that the stored data's backward compatibility between major releases isn't maintained.
- A major release is numbered by incrementing either the first or the second digit, such as 9.5 and 9.6.
- Minor releases are numbered by increasing the third digit of the release number, for example, 9.6.1 to 9.6.2.
  - Minor releases are only bug fixes.

- In PostgreSQL 10, the versioning policy has changed; major releases are numbered by incrementing the first number, that is, from 10 to 11.
- Minor releases are numbered by incrementing the second part of the number, for example, 10.0 to 10.1.

PostgreSQL Clients

- The PostgreSQL community unifies the look and feel of the client tools as much as possible; this makes it easy to use and learn.
- For example, the connection options are unified across all client tools.
- The following list shows the connection options for `psql`, which are common for other PostgreSQL clients, such as `createdb` and `createuser`:
  - `-d`: The database name
  - `-h`: The hostname or IP address
  - `-u`: The username
  - `-p`: The port

- Also, most PostgreSQL clients can use the environment variables supported by `libpq`, such as `PGHOST`, `PGDATABASE`, `PGPORT`, and `PGUSER`.
- The `libpq` environment variables can be used to determine the default connection parameter values.

The psql client

- The `psql` client tool is very handy in shell scripting, information retrieval, and learning the PostgreSQL internals.
- The following are some of the `psql` meta commands that are used daily:
  - `\d+ [pattern]`: This describes all the relevant information for a relation. In PostgreSQL, the term relation is used for a table, view, sequence, or index.
  - `\df+ [pattern]`: This describes a function.
  - `\z [pattern]`: This shows the relation access privileges.
  - `\timing`: Displays the execution time.
  - `\h`: Gives syntax help on the specified SQL command.
  - `\c`: Connects to a database.