Python

Pieter P

This page explains how to build Python 3 from source on Ubuntu.

Install dependencies and tools

First, install GCC 9, GNU Make and GNU Wget if you haven't already.

```
$ sudo add-apt-repository -y ppa:ubuntu-toolchain-r/test  # Repository for GCC 9
$ sudo apt update
$ sudo apt install gcc-9 g++-9 make wget
```

Also install the dependencies to build Python and its modules.

```
$ sudo apt install zlib1g-dev libbz2-dev libssl-dev uuid-dev libffi-dev libreadline-dev libsqlite3-dev tk-dev libbz2-dev
  libncurses5-dev libreadline6-dev libgdbm-dev liblzma-dev
```

On Ubuntu 18.04, you'll need compatibility development files for GNU dbm.

```
$ sudo apt install libgdbm-compat-dev
```

You can try to build Python without these dependencies, but then some of the optional modules will not be built.

Download and extract the source code

Next, download and extract the Python source code.

```
$ version="3.7.4"
$ python="Python-$version"
$ cd /tmp
$ wget "https://www.python.org/ftp/python/$version/$python.tgz"  # Download
$ tar xf $python.tgz  # Extract
```

Configure the build settings

You can now tune the settings for your build now. I'll use the standard version with optimizations, link-time optimizations, and IPv6 enabled. `--enable-shared` builds the shared libraries for Python. This allows other programs to use and embed Python.
The installation location is `~/.local`. This is a user-level installation, it's just for the current user, doesn't require sudo, and won't overwrite the Python version that comes with your Linux distribution.

On most distributions, `~/.local/lib` is not in the runtime linker's search path. Therefore, we need to specify the `rpath` during the linking stage.

```
$ cd "$python"
$ ./configure --prefix="$HOME/.local" \
          --enable-ipv6 \
          --enable-shared --with-lto --enable-optimizations \
          CC=gcc-9 CXX=g++-9 \
          'LDFLAGS=-Wl,-rpath,\$$ORIGIN/../lib'
```

To see all options, run the following command.

```
$ ./configure --help
```

Build Python

Actually build Python. This can easily take up to an hour, especially if you have optimizations enabled, because then it will run all tests.
The `-j` option tells make to compile multiple files in parallel, `nproc` gives the number of CPU cores of the system.

```
$ make -j$(nproc)
```

Install Python

Finally, install Python to the location specified as `prefix` in the configure step.

There are two possible install options: Either you install Python as the main/default version: this means that it will be installed as `python3`, and it will replace the previous default Python 3 version at the install location. The version you're installing will become the new default.
The second option is to install Python as an "alternative" version. The default Python 3 version will be preserved, and the new version will be installed as `python3.7`.

```
$ make install  # Replace default version
```

```
$ make altinstall  # Install alongside existing version, preserve default
```

If the installation location is not in your `PATH`, you'll have to add it yourself.

```
$ export PATH="$HOME/.local/bin:$PATH"
```

To make it permanent, add it to your `~/.profile` file, so it is added to your `PATH` every time you log in.

```
$ echo "export PATH=\"$HOME/.local/bin:$PATH\"" >> ~/.profile
```

Python itself will find its shared libraries without problems, because of the `rpath` linker option we added previously. However, if you are using other programs that require these libraries, you'll have to add `~/.local/lib` to your `LD_LIBRARY_PATH` environment variable.

```
$ export LD_LIBRARY_PATH="$HOME/.local/lib"
```

Shell Script

Here's a shell script that executes the previous steps for you.

```
#!/usr/bin/env bash

# Script to download and build Python 3 from source

set -ex

version="3.7.4"
builddir="/tmp"
python="Python-$version"
prefix="$HOME/.local"

# Install dependencies and build tools
sudo add-apt-repository -y ppa:ubuntu-toolchain-r/test
sudo apt-get update
sudo apt-get install -y \
    zlib1g-dev libbz2-dev libssl-dev uuid-dev libffi-dev libreadline-dev \
    libsqlite3-dev tk-dev libbz2-dev libncurses5-dev libreadline6-dev \
    libgdbm-dev liblzma-dev \
    wget make gcc-9 g++-9

# For Ubuntu 18.04 and later, another dependency is required for GNU dbm
source /etc/os-release
if (( $(echo "$VERSION_ID >= 18.04" | bc -l) ));
then
    sudo apt-get install libgdbm-compat-dev
fi

# Download and extract the Python source code
mkdir -p "$builddir"
cd $builddir
if [ ! -d "$python" ]
then
    wget "https://www.python.org/ftp/python/$version/$python.tgz"
    tar xf $python.tgz
fi

cd "$python"
./configure --prefix="$prefix" \
    --enable-ipv6 \
    --enable-shared --with-lto --enable-optimizations \
    CC=gcc-9 CXX=g++-9 \
    'LDFLAGS=-Wl,-rpath,\$$ORIGIN/../lib'

make -j$[$(nproc) * 2]
make altinstall
```

You can download it here. Then allow execution and run it:

```
$ chmod +x python.sh
$ ./python.sh
```

Tested on

- Ubuntu 16.04 - Python 3.7.3
- Ubuntu 18.04 - Python 3.7.4
