Red Hat Enterprise Linux 9

Installing and using dynamic programming languages

Installing and using Python and PHP in Red Hat Enterprise Linux 9
Red Hat Enterprise Linux 9 Installing and using dynamic programming languages

Installing and using Python and PHP in Red Hat Enterprise Linux 9
Abstract

Install and use Python 3, package Python 3 RPMs, and learn how to handle interpreter directives in Python scripts. Install the PHP scripting language, use PHP with the Apache HTTP Server or the nginx web server, and run a PHP script from a command-line interface.
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MAKING OPEN SOURCE MORE INCLUSIVE

Red Hat is committed to replacing problematic language in our code, documentation, and web properties. We are beginning with these four terms: master, slave, blacklist, and whitelist. Because of the enormity of this endeavor, these changes will be implemented gradually over several upcoming releases. For more details, see our CTO Chris Wright’s message.
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2. Use your cursor to highlight the part of the text that you want to comment on.

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1. Log in to the Bugzilla website.

2. Select the correct version from the Version menu.

3. Enter a descriptive title in the Summary field.

4. Enter your suggestion for improvement in the Description field. Include links to the relevant parts of the documentation.

5. Click Submit Bug.
CHAPTER 1. INTRODUCTION TO PYTHON

Python is a high-level programming language that supports multiple programming paradigms, such as object-oriented, imperative, functional, and procedural paradigms. Python has dynamic semantics and can be used for general-purpose programming.

With Red Hat Enterprise Linux, many packages that are installed on the system, such as packages providing system tools, tools for data analysis, or web applications, are written in Python. To use these packages, you must have the `python*` packages installed.

1.1. PYTHON VERSIONS

Python 3.9 is the default Python implementation in RHEL 9. Python 3.9 is distributed in a non-modular `python3` RPM package in the BaseOS repository and is usually installed by default. Python 3.9 will be supported for the whole life cycle of RHEL 9.

Additional versions of Python 3 are distributed as non-modular RPM packages with a shorter life cycle through the AppStream repository in minor RHEL 9 releases. You can install these additional Python 3 versions in parallel with Python 3.9.

Python 2 is not distributed with RHEL 9.

Table 1.1. Python versions in RHEL 9

<table>
<thead>
<tr>
<th>Version</th>
<th>Package to install</th>
<th>Command examples</th>
<th>Available since</th>
<th>Life cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Python 3.9</td>
<td>python3</td>
<td>python3, pip3</td>
<td>RHEL 9.0</td>
<td>full RHEL 9</td>
</tr>
<tr>
<td>Python 3.11</td>
<td>python3.11</td>
<td>python3.11, pip3.11</td>
<td>RHEL 9.2</td>
<td>shorter</td>
</tr>
</tbody>
</table>

For details about the length of support, see Red Hat Enterprise Linux Life Cycle and Red Hat Enterprise Linux Application Streams Life Cycle.

1.2. MAJOR DIFFERENCES IN THE PYTHON ECOSYSTEM SINCE RHEL 8

This section summarizes major changes in the Python ecosystem in RHEL 9 compared to RHEL 8.

The unversioned `python` command

The unversioned form of the `python` command (/usr/bin/python) is available in the `python-unversioned-command` package. On some systems, this package is not installed by default. To install the unversioned form of the `python` command manually, use the `dnf install /usr/bin/python` command.

In RHEL 9, the unversioned form of the `python` command points to the default Python 3.9 version and it is an equivalent to the `python3` and `python3.9` commands. In RHEL 9, you cannot configure the unversioned command to point to a different version than Python 3.9.

The `python` command is intended for interactive sessions. In production, it is recommended to use `python3`, `python3.9`, or `python3.11` explicitly.
You can uninstall the unversioned `python` command by using the `dnf remove /usr/bin/python` command.

If you need a different `python` or `python3` command, you can create custom symlinks in `/usr/local/bin` or `~/.local/bin`, or use a Python virtual environment.

Several other unversioned commands are available, such as `/usr/bin/pip` in the `python3-pip` package. In RHEL 9, all unversioned commands point to the default Python 3.9 version.

**Architecture-specific Python wheels**

Architecture-specific Python wheels built on RHEL 9 newly adhere to the upstream architecture naming, which allows customers to build their Python wheels on RHEL 9 and install them on non-RHEL systems. Python wheels built on previous releases of RHEL are compatible with later versions and can be installed on RHEL 9. Note that this affects only wheels containing Python extensions, which are built for each architecture, not Python wheels with pure Python code, which is not architecture-specific.
CHAPTER 2. INSTALLING AND USING PYTHON

In RHEL 9, Python 3.9 is the default Python implementation. Since RHEL 9.2, Python 3.11 is available as the python3.11 package suite.

The unversioned python command points to the default Python 3.9 version.

2.1. INSTALLING PYTHON 3

The default Python implementation is usually installed by default. To install it manually, use the following procedure.

Procedure

- To install Python 3.9, use:
  # dnf install python3

- To install Python 3.11, use:
  # dnf install python3.11

Verification steps

- To verify the Python version installed on your system, use the --version option with the python command specific for your required version of Python.

  For Python 3.9:
  $ python3 --version

  For Python 3.11:
  $ python3.11 --version

2.2. INSTALLING ADDITIONAL PYTHON 3 PACKAGES

Packages prefixed with python3- contain add-on modules for the default Python 3.9 version. Packages prefixed with python3.11- contain add-on modules for Python 3.11.

Procedure

- To install the Requests module for Python 3.9, use:
  # dnf install python3-requests

- To install the pip package installer from Python 3.9, use:
  # dnf install python3-pip

- To install the pip package installer from Python 3.11, use:
Additional resources

- Upstream documentation about Python add-on modules

2.3. INSTALLING ADDITIONAL PYTHON 3 TOOLS FOR DEVELOPERS

Additional Python tools for developers are distributed mostly through the CodeReady Linux Builder (CRB) repository.

The `python3-pytest` package and its dependencies are available in the AppStream repository.

The CRB repository contains, for example, the following packages:

- `python3*-idle`
- `python3*-debug`
- `python3*-Cython`
- `python3.11-pytest` and its dependencies.

**IMPORTANT**

The content in the CodeReady Linux Builder repository is unsupported by Red Hat.

**NOTE**

Not all upstream Python-related packages are available in RHEL.

To install packages from the CRB repository, use the following procedure.

**Procedure**

1. Enable the CodeReady Linux Builder repository:

   ```bash
   # subscription-manager repos --enable codeready-builder-for-rhel-9-x86_64-rpms
   ```

2. Install the `python3*-Cython` package:

   - For Python 3.9:
     ```bash
     # dnf install python3-Cython
     ```

   - For Python 3.11:
     ```bash
     # dnf install python3.11-Cython
     ```

**Additional resources**

- How to enable and make use of content within CodeReady Linux Builder
2.4. USING PYTHON

The following procedure contains examples of running the **Python** interpreter or **Python**-related commands.

**Prerequisites**

- Ensure that **Python** is installed.
- If you want to download and install third-party applications for **Python 3.11**, install the **python3.11-pip** package.

**Procedure**

- To run the **Python 3.9** interpreter or related commands, use, for example:
  
  ```
  $ python3
  $ python3 -m venv --help
  $ python3 -m pip install package
  $ pip3 install package
  ```

- To run the **Python 3.11** interpreter or related commands, use, for example:
  
  ```
  $ python3.11
  $ python3.11 -m venv --help
  $ python3.11 -m pip install package
  $ pip3.11 install package
  ```
CHAPTER 3. PACKAGING PYTHON 3 RPMS

You can install Python packages on your system either from the upstream PyPI repository using the pip installer, or using the DNF package manager. DNF uses the RPM package format, which offers more downstream control over the software.

The packaging format of native Python packages is defined by Python Packaging Authority (PyPA) Specifications. Most Python projects use the distutils or setuptools utilities for packaging, and defined package information in the setup.py file. However, possibilities of creating native Python packages have evolved over time. For more information about emerging packaging standards, see pyproject-rpm-macros.

This chapter describes how to package a Python project that uses setup.py into an RPM package. This approach provides the following advantages compared to native Python packages:

- Dependencies on Python and non-Python packages are possible and strictly enforced by the DNF package manager.
- You can cryptographically sign the packages. With cryptographic signing, you can verify, integrate, and test content of RPM packages with the rest of the operating system.
- You can execute tests during the build process.

3.1. SPEC FILE DESCRIPTION FOR A PYTHON PACKAGE

A SPEC file contains instructions that the rpmbuild utility uses to build an RPM. The instructions are included in a series of sections. A SPEC file has two main parts in which the sections are defined:

- Preamble (contains a series of metadata items that are used in the Body)
- Body (contains the main part of the instructions)

An RPM SPEC file for Python projects has some specifics compared to non-Python RPM SPEC files.

IMPORTANT

A name of any RPM package of a Python library must always include the python3- or python3.11- prefix.

Other specifics are shown in the following SPEC file example for the python3*-pello package. For description of such specifics, see the notes below the example.

```%
global python3_pkgversion 3.11

Name: python-pello
Version: 1.0.2
Release: 1%{?dist}
Summary: Example Python library
License: MIT
URL: https://github.com/fedora-python/Pello
Source: %{url}/archive/v%{version}/Pello-%{version}.tar.gz
BuildArch: noarch
```
By defining the `python3_pkgversion` macro, you set which Python version this package will be built for. To build for the default Python version 3.9, either set the macro to its default value 3 or remove the line entirely.

BuildRequires: python%{python3_pkgversion}-devel

# Build dependencies needed to be specified manually
BuildRequires: python%{python3_pkgversion}-setuptools

# Test dependencies needed to be specified manually
# Also runtime dependencies need to be BuildRequired manually to run tests during build
BuildRequires: python%{python3_pkgversion}-pytest >= 3

%global _description %{expand:
Pello is an example package with an executable that prints Hello World! on the command line.}

description _description

%package -n python%{python3_pkgversion}-pello
Summary: %{summary}

description -n python%{python3_pkgversion}-pello _description

%prep
%autosetup -p1 -n Pello-%{version}

%build
# The macro only supported projects with setup.py
%py3_build

%install
# The macro only supported projects with setup.py
%py3_install

%check
%{pytest}

# Note that there is no %%files section for the unversioned python module
%files -n python%{python3_pkgversion}-pello
%doc README.md
%license LICENSE.txt
%{_bindir}/pello_greeting

# The library files needed to be listed manually
%(python3_sitelib)/pello/

# The metadata files needed to be listed manually
%(python3_sitelib)/Pello-*.egg-info/
When packaging a Python project into RPM, always add the `python-` prefix to the original name of the project. The original name here is `pello` and, therefore, the name of the Source RPM (SRPM) is `python-pello`.

**BuildRequires** specifies what packages are required to build and test this package. In **BuildRequires**, always include items providing tools necessary for building Python packages: `python3-devel` (or `python3.11-devel`) and the relevant projects needed by the specific software that you package, for example, `python3-setuptools` (or `python3.11-setuptools`) or the runtime and testing dependencies needed to run the tests in the `%check` section.

When choosing a name for the binary RPM (the package that users will be able to install), add a versioned Python prefix. Use the `python3-` prefix for the default Python 3.9 or the `python3.11-` prefix for Python 3.11. You can use the `%{python3_pkgversion}` macro, which evaluates to `3` for the default Python version 3.9 unless you set it to an explicit version, for example, `3.11` (see footnote 1).

The `%py3_build` and `%py3_install` macros run the `setup.py build` and `setup.py install` commands, respectively, with additional arguments to specify installation locations, the interpreter to use, and other details.

The `%check` section should run the tests of the packaged project. The exact command depends on the project itself, but it is possible to use the `%pytest` macro to run the `pytest` command in an RPM-friendly way.

### 3.2. COMMON MACROS FOR PYTHON 3 RPMS

In a SPEC file, always use the macros that are described in the following **Macros for Python 3 RPMs** table rather than hardcoding their values. You can redefine which Python 3 version is used in these macros by defining the `python3_pkgversion` macro on top of your SPEC file (see Section 3.1, "SPEC file description for a Python package"). If you define the `python3_pkgversion` macro, the values of the macros described in the following table will reflect the specified Python 3 version.

<table>
<thead>
<tr>
<th>Macro</th>
<th>Normal Definition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>%{python3_pkgversion}</code></td>
<td>3</td>
<td>The Python version that is used by all other macros. Can be redefined to 3.11 to use Python 3.11</td>
</tr>
<tr>
<td><code>%{python3}</code></td>
<td>/usr/bin/python3</td>
<td>The Python 3 interpreter</td>
</tr>
<tr>
<td><code>%{python3_version}</code></td>
<td>3.9</td>
<td>The major.minor version of the Python 3 interpreter</td>
</tr>
<tr>
<td><code>%{python3_sitelib}</code></td>
<td>/usr/lib/python3.9/site-packages</td>
<td>The location where pure-Python modules are installed</td>
</tr>
<tr>
<td><code>%{python3_sitearch}</code></td>
<td>/usr/lib64/python3.9/site-packages</td>
<td>The location where modules containing architecture-specific extension modules are installed</td>
</tr>
<tr>
<td>Macro</td>
<td>Normal Definition</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>%py3_build</td>
<td></td>
<td>Runs the <code>setup.py build</code> command with arguments suitable for an RPM package</td>
</tr>
<tr>
<td>%py3_install</td>
<td></td>
<td>Runs the <code>setup.py install</code> command with arguments suitable for an RPM package</td>
</tr>
<tr>
<td>% {py3_shebang_flags}</td>
<td>s</td>
<td>The default set of flags for the Python interpreter directives macro, <code>%py3_shebang_fix</code></td>
</tr>
<tr>
<td>%py3_shebang_fix</td>
<td></td>
<td>Changes Python interpreter directives to <code>#! %python3</code>, preserves any existing flags (if found), and adds flags defined in the <code>% {py3_shebang_flags}</code> macro</td>
</tr>
</tbody>
</table>

Additional resources
- Python macros in upstream documentation

3.3. USING AUTOMATICALLY GENERATED DEPENDENCIES FOR PYTHON RPMS

The following procedure describes how to use automatically generated dependencies when packaging a Python project as an RPM.

Prerequisites
- A SPEC file for the RPM exists. For more information, see SPEC file description for a Python package.

Procedure

1. Make sure that one of the following directories containing upstream-provided metadata is included in the resulting RPM:
   - .dist-info
   - .egg-info
   The RPM build process automatically generates virtual `pythonX.Ydist` provides from these directories, for example:

   ```
   python3.9dist(pello)
   ```

   The Python dependency generator then reads the upstream metadata and generates runtime requirements for each RPM package using the generated `pythonX.Ydist` virtual provides. For example, a generated requirements tag might look as follows:

   ```
   Requires: python3.9dist(requests)
   ```
2. Inspect the generated requires.

3. To remove some of the generated requires, use one of the following approaches:
   a. Modify the upstream-provided metadata in the %prep section of the SPEC file.
   b. Use automatic filtering of dependencies described in the upstream documentation.

4. To disable the automatic dependency generator, include the `%{\python_disable_dependency_generator}` macro above the main package's %description declaration.

Additional resources
   - Automatically generated dependencies
In Red Hat Enterprise Linux 9, executable Python scripts are expected to use interpreter directives (also known as hashbangs or shebangs) that explicitly specify at a minimum the major Python version. For example:

```bash
#!/usr/bin/python3
#!/usr/bin/python3.9
#!/usr/bin/python3.11
```

The `/usr/lib/rpm/redhat/brp-mangle-shebangs` buildroot policy (BRP) script is run automatically when building any RPM package, and attempts to correct interpreter directives in all executable files.

The BRP script generates errors when encountering a Python script with an ambiguous interpreter directive, such as:

```bash
#!/usr/bin/python
```

or

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

## 4.1. MODIFYING INTERPRETER DIRECTIVES IN PYTHON SCRIPTS

Use the following procedure to modify interpreter directives in Python scripts that cause build errors at RPM build time.

### Prerequisites

- Some of the interpreter directives in your Python scripts cause a build error.

### Procedure

- To modify interpreter directives, complete one of the following tasks:
  - Use the following macro in the `%prep` section of your `SPEC` file:
    ```bash
    # %py3_shebang_fix SCRIPTNAME ...
    ```

    `SCRIPTNAME` can be any file, directory, or a list of files and directories.

    As a result, all listed files and all `.py` files in listed directories will have their interpreter directives modified to point to `%{python3}`. Existing flags from the original interpreter directive will be preserved and additional flags defined in the `%{py3_shebang_flags}` macro will be added. You can redefine the `%{py3_shebang_flags}` macro in your `SPEC` file to change the flags that will be added.

  - Apply the `pathfix.py` script from the `python3-devel` package:
    ```bash
    # pathfix.py -pn -i %{python3} PATH ...
    ```

    You can specify multiple paths. If a `PATH` is a directory, `pathfix.py` recursively scans for any
Python scripts matching the pattern ^[a-zA-Z0-9_]+\..py$, not only those with an ambiguous interpreter directive. Add the command above to the %prep section or at the end of the %install section.

- Modify the packaged Python scripts so that they conform to the expected format. For this purpose, you can use the pathfix.py script outside the RPM build process, too. When running pathfix.py outside an RPM build, replace %python3 from the preceding example with a path for the interpreter directive, such as /usr/bin/python3 or /usr/bin/python3.11.

Additional resources

- Interpreter invocation
CHAPTER 5. USING THE PHP SCRIPTING LANGUAGE

Hypertext Preprocessor (PHP) is a general-purpose scripting language mainly used for server-side scripting, which enables you to run the PHP code using a web server.

In RHEL 9, PHP is available in the following versions and formats:

- PHP 8.0 as the `php` RPM package
- PHP 8.1 as the `php:8.1` module stream

5.1. INSTALLING THE PHP SCRIPTING LANGUAGE

This section describes how to install PHP.

**Procedure**

- To install PHP 8.0, use:
  ```
  # dnf install php
  ```

- To install the `php:8.1` module stream with the default profile, use:
  ```
  # dnf module install php:8.1
  ```

  The default `common` profile installs also the `php-fpm` package, and preconfigures PHP for use with the Apache HTTP Server or nginx.

- To install a specific profile of the `php:8.1` module stream, use:
  ```
  # dnf module install php:8.1/profile
  ```

  Available profiles are as follows:

  - **`common`** - The default profile for server-side scripting using a web server. It includes the most widely used extensions.

  - **`minimal`** - This profile installs only the command-line interface for scripting with PHP without using a web server.

  - **`devel`** - This profile includes packages from the common profile and additional packages for development purposes.
    For example, to install PHP 8.1 for use without a web server, use:
    ```
    # dnf module install php:8.1/minimal
    ```

**Additional resources**

- Managing software with the DNF tool

5.2. USING THE PHP SCRIPTING LANGUAGE WITH A WEB SERVER
5.2.1. Using PHP with the Apache HTTP Server

In Red Hat Enterprise Linux 9, the Apache HTTP Server enables you to run PHP as a FastCGI process server. FastCGI Process Manager (FPM) is an alternative PHP FastCGI daemon that allows a website to manage high loads. PHP uses FastCGI Process Manager by default in RHEL 9.

This section describes how to run the PHP code using the FastCGI process server.

Prerequisites

- The PHP scripting language is installed on your system.

Procedure

1. Install the httpd package:

   # dnf install httpd

2. Start the Apache HTTP Server:

   # systemctl start httpd

   Or, if the Apache HTTP Server is already running on your system, restart the httpd service after installing PHP:

   # systemctl restart httpd

3. Start the php-fpm service:

   # systemctl start php-fpm

4. Optional: Enable both services to start at boot time:

   # systemctl enable php-fpm httpd

5. To obtain information about your PHP settings, create the index.php file with the following content in the /var/www/html/ directory:


6. To run the index.php file, point the browser to:

   http://<hostname>/

7. Optional: Adjust configuration if you have specific requirements:

   - /etc/httpd/conf/httpd.conf - generic httpd configuration
   - /etc/httpd/conf.d/php.conf - PHP-specific configuration for httpd
   - /usr/lib/systemd/system/httpd.service.d/php-fpm.conf - by default, the php-fpm service is started with httpd
Example 5.1. Running a "Hello, World!" PHP script using the Apache HTTP Server

1. Create a hello directory for your project in the /var/www/html/ directory:

   # mkdir hello

2. Create a hello.php file in the /var/www/html/hello/ directory with the following content:

   # <!DOCTYPE html>
   <html>
   <head>
   <title>Hello, World! Page</title>
   </head>
   <body>
   <?php
   echo 'Hello, World!';
   ?></body>
   </html>

3. Start the Apache HTTP Server:

   # systemctl start httpd

4. To run the hello.php file, point the browser to:

   http://<hostname>/hello/hello.php

As a result, a web page with the “Hello, World!” text is displayed.

Additional resources

- Setting up the Apache HTTP web server

5.2.2. Using PHP with the nginx web server

This section describes how to run PHP code through the nginx web server.

Prerequisites

- The PHP scripting language is installed on your system.

Procedure

1. Install the nginx package:

   # dnf install nginx
2. Start the **nginx** server:

```
# systemctl start nginx
```

Or, if the **nginx** server is already running on your system, restart the **nginx** service after installing PHP:

```
# systemctl restart nginx
```

3. Start the **php-fpm** service:

```
# systemctl start php-fpm
```

4. Optional: Enable both services to start at boot time:

```
# systemctl enable php-fpm nginx
```

5. To obtain information about your PHP settings, create the **index.php** file with the following content in the `/usr/share/nginx/html/` directory:

```
```

6. To run the **index.php** file, point the browser to:

```
http://<hostname>/
```

7. Optional: Adjust configuration if you have specific requirements:

- `/etc/nginx/nginx.conf` - nginx main configuration
- `/etc/nginx/conf.d/php-fpm.conf` - FPM configuration for nginx
- `/etc/php-fpm.conf` - FPM main configuration
- `/etc/php-fpm.d/www.conf` - default www pool configuration

---

**Example 5.2. Running a "Hello, World!" PHP script using the nginx server**

1. Create a **hello** directory for your project in the `/usr/share/nginx/html/` directory:

```
# mkdir hello
```

2. Create a **hello.php** file in the `/usr/share/nginx/html/hello/` directory with the following content:

```
<!DOCTYPE html>
<html>
<head>
<title>Hello, World! Page</title>
</head>
<body>
<?php
    echo 'Hello, World!';
</body>
</html>
```
3. Start the nginx server:

# systemctl start nginx

4. To run the hello.php file, point the browser to:

http://<hostname>/hello/hello.php

As a result, a web page with the “Hello, World!” text is displayed.

Additional resources

- Setting up and configuring NGINX

### 5.3. RUNNING A PHP SCRIPT USING THE COMMAND-LINE INTERFACE

A PHP script is usually run using a web server, but also can be run using the command-line interface.

**Prerequisites**

- The PHP scripting language is installed on your system.

**Procedure**

1. In a text editor, create a filename.php file
   Replace filename with the name of your file.

2. Execute the created filename.php file from the command line:

   # php filename.php

**Example 5.3. Running a "Hello, World!" PHP script using the command-line interface**

1. Create a hello.php file with the following content using a text editor:

   ```php
   <?php
   echo 'Hello, World!';
   ?>
   ```

2. Execute the hello.php file from the command line:

   # php hello.php

   As a result, “Hello, World!” is printed.
5.4. ADDITIONAL RESOURCES

- `httpd(8)` – The manual page for the `httpd` service containing the complete list of its command-line options.

- `httpd.conf(5)` – The manual page for `httpd` configuration, describing the structure and location of the `httpd` configuration files.

- `nginx(8)` – The manual page for the `nginx` web server containing the complete list of its command-line options and list of signals.

- `php-fpm(8)` – The manual page for PHP FPM describing the complete list of its command-line options and configuration files.