28.3. venv — Creation of virtual environments

New in version 3.3.

Source code: Lib/venv/

The venv module provides support for creating lightweight "virtual environments" with their own site directories, optionally isolated from system site directories. Each virtual environment has its own Python binary (allowing creation of environments with various Python versions) and can have its own independent set of installed Python packages in its site directories.

See **PEP 405** for more information about Python virtual environments.

> **Note:** The `pyvenv` script has been deprecated as of Python 3.6 in favor of using `python3 -m venv` to help prevent any potential confusion as to which Python interpreter a virtual environment will be based on.

28.3.1. Creating virtual environments

Creation of virtual environments is done by executing the command `venv`:

```
python3 -m venv /path/to/new/virtual/environment
```

Running this command creates the target directory (creating any parent directories that don't exist already) and places a `pyvenv.cfg` file in it with a `home` key pointing to the Python installation from which the command was run. It also creates a `bin` (or `Scripts` on Windows) subdirectory containing a copy of the `python` binary (or binaries, in the case of Windows). It also creates an (initially empty) `lib/pythonX.Y/site-packages` subdirectory (on Windows, this is `Lib\site-packages`). If an existing directory is specified, it will be re-used.

Deprecated since version 3.6: `pyvenv` was the recommended tool for creating virtual environments for Python 3.3 and 3.4, and is deprecated in Python 3.6.

Changed in version 3.5: The use of `venv` is now recommended for creating virtual environments.

> **See also:** Python Packaging User Guide: Creating and using virtual environments

On Windows, invoke the `venv` command as follows:

```
c:\>c:\Python35\python -m venv c:\path\to\myenv
```

Alternatively, if you configured the `PATH` and `PATHEXT` variables for your Python installation:

```
c:\>python -m venv c:\path\to\myenv
```

The command, if run with `-h`, will show the available options:

```
usage: venv [-h] [--system-site-packages] [--symlinks | --copies] [--c
            [--upgrade] [--without-pip]
            ENV_DIR [ENV_DIR ...]

Creates virtual Python environments in one or more target directories.

positional arguments:
  ENV_DIR               A directory to create the environment in.

optional arguments:
  -h, --help            show this help message and exit
  --system-site-packages
                        Give the virtual environment access to the sys
                        site-packages dir.
  --symlinks            Try to use symlinks rather than copies, when s
                        are not the default for the platform.
  --copies              Try to use copies rather than symlinks, even w
                        symlinks are the default for the platform.
  --clear               Delete the contents of the environment directo
                        already exists, before environment creation.
  --upgrade             Upgrade the environment directory to use this
                        of Python, assuming Python has been upgraded i
  --without-pip         Skips installing or upgrading pip in the virtu
                        environment (pip is bootstrapped by default)

Once an environment has been created, you may wish to activate it, e.g
sourcing an activate script in its bin directory.
```

Changed in version 3.4: Installs pip by default, added the `--without-pip` and `--copies` options

Changed in version 3.4: In earlier versions, if the target directory already existed, an error was raised, unless the `--clear` or `--upgrade` option was provided.

The created `pyvenv.cfg` file also includes the `include-system-site-packages` key, set to `true` if `venv` is run with the `--system-site-packages` option, `false` otherwise.

Unless the `--without-pip` option is given, `ensurepip` will be invoked to bootstrap `pip` into the virtual environment.

Multiple paths can be given to `venv`, in which case an identical virtual environment will be created, according to the given options, at each provided path.

Once a virtual environment has been created, it can be "activated" using a script in the virtual environment's binary directory. The invocation of the script is platform-specific:

Platform	Shell	Command to activate virtual environment
Posix	bash/zsh	$ source <venv>/bin/activate
	fish	$. <venv>/bin/activate.fish
	csh/tcsh	$ source <venv>/bin/activate.csh
Windows	cmd.exe	C:\> <venv>\Scripts\activate.bat
	PowerShell	PS C:\> <venv>\Scripts\Activate.ps1

You don't specifically *need* to activate an environment; activation just prepends the virtual environment's binary directory to your path, so that "python" invokes the virtual environment's Python interpreter and you can run installed scripts without having to use their full path. However, all scripts installed in a virtual environment should be runnable without activating it, and run with the virtual environment's Python automatically.

You can deactivate a virtual environment by typing "deactivate" in your shell. The exact mechanism is platform-specific: for example, the Bash activation script defines a "deactivate" function, whereas on Windows there are separate scripts called `deactivate.bat` and `Deactivate.ps1` which are installed when the virtual environment is created.

New in version 3.4: `fish` and `csh` activation scripts.

Note: A virtual environment is a Python environment such that the Python interpreter, libraries and scripts installed into it are isolated from those installed in other virtual environments, and (by default) any libraries installed in a "system" Python, i.e., one which is installed as part of your operating system.

A virtual environment is a directory tree which contains Python executable files and other files which indicate that it is a virtual environment.

Common installation tools such as `Setuptools` and `pip` work as expected with virtual environments. In other words, when a virtual environment is active, they in-

stall Python packages into the virtual environment without needing to be told to do so explicitly.

When a virtual environment is active (i.e., the virtual environment's Python interpreter is running), the attributes `sys.prefix` and `sys.exec_prefix` point to the base directory of the virtual environment, whereas `sys.base_prefix` and `sys.base_exec_prefix` point to the non-virtual environment Python installation which was used to create the virtual environment. If a virtual environment is not active, then `sys.prefix` is the same as `sys.base_prefix` and `sys.exec_prefix` is the same as `sys.base_exec_prefix` (they all point to a non-virtual environment Python installation).

When a virtual environment is active, any options that change the installation path will be ignored from all distutils configuration files to prevent projects being inadvertently installed outside of the virtual environment.

When working in a command shell, users can make a virtual environment active by running an `activate` script in the virtual environment's executables directory (the precise filename is shell-dependent), which prepends the virtual environment's directory for executables to the `PATH` environment variable for the running shell. There should be no need in other circumstances to activate a virtual environment—scripts installed into virtual environments have a "shebang" line which points to the virtual environment's Python interpreter. This means that the script will run with that interpreter regardless of the value of `PATH`. On Windows, "shebang" line processing is supported if you have the Python Launcher for Windows installed (this was added to Python in 3.3 - see **PEP 397** for more details). Thus, double-clicking an installed script in a Windows Explorer window should run the script with the correct interpreter without there needing to be any reference to its virtual environment in `PATH`.

28.3.2. API

The high-level method described above makes use of a simple API which provides mechanisms for third-party virtual environment creators to customize environment creation according to their needs, the `EnvBuilder` class.

class `venv.`**`EnvBuilder`**(*system_site_packages=False*, *clear=False*, *symlinks=False*, *upgrade=False*, *with_pip=False*, *prompt=None*)

The `EnvBuilder` class accepts the following keyword arguments on instantiation:

- `system_site_packages` – a Boolean value indicating that the system Python site-packages should be available to the environment (defaults to `False`).
- `clear` – a Boolean value which, if true, will delete the contents of any existing target directory, before creating the environment.
- `symlinks` – a Boolean value indicating whether to attempt to symlink the Python binary (and any necessary DLLs or other binaries, e.g. `pythonw.exe`), rather than copying.
- `upgrade` – a Boolean value which, if true, will upgrade an existing environment with the running Python - for use when that Python has been upgraded in-place (defaults to `False`).
- `with_pip` – a Boolean value which, if true, ensures pip is installed in the virtual environment. This uses `ensurepip` with the `--default-pip` option.
- `prompt` – a String to be used after virtual environment is activated (defaults to `None` which means directory name of the environment would be used).

Changed in version 3.4: Added the `with_pip` parameter

New in version 3.6: Added the `prompt` parameter

Creators of third-party virtual environment tools will be free to use the provided `EnvBuilder` class as a base class.

The returned env-builder is an object which has a method, `create`:

`create`(*env_dir*)

This method takes as required argument the path (absolute or relative to the current directory) of the target directory which is to contain the virtual environment. The `create` method will either create the environment in the specified directory, or raise an appropriate exception.

The `create` method of the `EnvBuilder` class illustrates the hooks available for subclass customization:

```
def create(self, env_dir):
    """
    Create a virtualized Python environment in a directory.
    env_dir is the target directory to create an environment ir
    """
    env_dir = os.path.abspath(env_dir)
    context = self.ensure_directories(env_dir)
    self.create_configuration(context)
    self.setup_python(context)
    self.setup_scripts(context)
    self.post_setup(context)
```

Each of the methods `ensure_directories()`, `create_configuration()`, `setup_python()`, `setup_scripts()` and `post_setup()` can be overridden.

ensure_directories(*env_dir*)

Creates the environment directory and all necessary directories, and returns a context object. This is just a holder for attributes (such as paths), for use by the other methods. The directories are allowed to exist already, as long as either `clear` or `upgrade` were specified to allow operating on an existing environment directory.

create_configuration(*context*)

Creates the `pyvenv.cfg` configuration file in the environment.

setup_python(*context*)

Creates a copy of the Python executable (and, under Windows, DLLs) in the environment. On a POSIX system, if a specific executable `python3.x` was used, symlinks to `python` and `python3` will be created pointing to that executable, unless files with those names already exist.

setup_scripts(*context*)

Installs activation scripts appropriate to the platform into the virtual environment.

post_setup(*context*)

A placeholder method which can be overridden in third party implementations to pre-install packages in the virtual environment or perform other post-creation steps.

In addition, `EnvBuilder` provides this utility method that can be called from `setup_scripts()` or `post_setup()` in subclasses to assist in installing custom scripts into the virtual environment.

install_scripts(*context*, *path*)

path is the path to a directory that should contain subdirectories “common”, “posix”, “nt”, each containing scripts destined for the bin directory in the environment. The contents of “common” and the directory corresponding to `os.name` are copied after some text replacement of placeholders:

- `__VENV_DIR__` is replaced with the absolute path of the environment directory.
- `__VENV_NAME__` is replaced with the environment name (final path segment of environment directory).
- `__VENV_PROMPT__` is replaced with the prompt (the environment name surrounded by parentheses and with a following space)

- `__VENV_BIN_NAME__` is replaced with the name of the bin directory (either `bin` or `Scripts`).
- `__VENV_PYTHON__` is replaced with the absolute path of the environment's executable.

The directories are allowed to exist (for when an existing environment is being upgraded).

There is also a module-level convenience function:

`venv.`**`create`**(*env_dir*, *system_site_packages=False*, *clear=False*, *symlinks=False*, *with_pip=False*)

Create an `EnvBuilder` with the given keyword arguments, and call its `create()` method with the *env_dir* argument.

Changed in version 3.4: Added the `with_pip` parameter

28.3.3. An example of extending `EnvBuilder`

The following script shows how to extend `EnvBuilder` by implementing a subclass which installs setuptools and pip into a created virtual environment:

```
import os
import os.path
from subprocess import Popen, PIPE
import sys
from threading import Thread
from urllib.parse import urlparse
from urllib.request import urlretrieve
import venv

class ExtendedEnvBuilder(venv.EnvBuilder):
    """
    This builder installs setuptools and pip so that you can pip or
    easy_install other packages into the created virtual environment.

    :param nodist: If True, setuptools and pip are not installed into
                   created virtual environment.
    :param nopip: If True, pip is not installed into the created
                  virtual environment.
    :param progress: If setuptools or pip are installed, the progress
                     installation can be monitored by passing a progre
                     callable. If specified, it is called with two
                     arguments: a string indicating some progress, and
                     context indicating where the string is coming fro
                     The context argument can have one of three values
                     'main', indicating that it is called from virtual
                     itself, and 'stdout' and 'stderr', which are obta
                     by reading lines from the output streams of a sub
```

```
                    which is used to install the app.

                    If a callable is not specified, default progress
                    information is output to sys.stderr.
    """

    def __init__(self, *args, **kwargs):
        self.nodist = kwargs.pop('nodist', False)
        self.nopip = kwargs.pop('nopip', False)
        self.progress = kwargs.pop('progress', None)
        self.verbose = kwargs.pop('verbose', False)
        super().__init__(*args, **kwargs)

    def post_setup(self, context):
        """
        Set up any packages which need to be pre-installed into the
        virtual environment being created.

        :param context: The information for the virtual environment
                        creation request being processed.
        """
        os.environ['VIRTUAL_ENV'] = context.env_dir
        if not self.nodist:
            self.install_setuptools(context)
        # Can't install pip without setuptools
        if not self.nopip and not self.nodist:
            self.install_pip(context)

    def reader(self, stream, context):
        """
        Read lines from a subprocess' output stream and either pass to
        callable (if specified) or write progress information to sys.s
        """
        progress = self.progress
        while True:
            s = stream.readline()
            if not s:
                break
            if progress is not None:
                progress(s, context)
            else:
                if not self.verbose:
                    sys.stderr.write('.')
                else:
                    sys.stderr.write(s.decode('utf-8'))
                sys.stderr.flush()
        stream.close()

    def install_script(self, context, name, url):
        _, _, path, _, _, _ = urlparse(url)
        fn = os.path.split(path)[-1]
        binpath = context.bin_path
```

```
        distpath = os.path.join(binpath, fn)
        # Download script into the virtual environment's binaries fold
        urlretrieve(url, distpath)
        progress = self.progress
        if self.verbose:
            term = '\n'
        else:
            term = ''
        if progress is not None:
            progress('Installing %s ...%s' % (name, term), 'main')
        else:
            sys.stderr.write('Installing %s ...%s' % (name, term))
            sys.stderr.flush()
        # Install in the virtual environment
        args = [context.env_exe, fn]
        p = Popen(args, stdout=PIPE, stderr=PIPE, cwd=binpath)
        t1 = Thread(target=self.reader, args=(p.stdout, 'stdout'))
        t1.start()
        t2 = Thread(target=self.reader, args=(p.stderr, 'stderr'))
        t2.start()
        p.wait()
        t1.join()
        t2.join()
        if progress is not None:
            progress('done.', 'main')
        else:
            sys.stderr.write('done.\n')
        # Clean up - no longer needed
        os.unlink(distpath)

    def install_setuptools(self, context):
        """
        Install setuptools in the virtual environment.

        :param context: The information for the virtual environment
                        creation request being processed.
        """
        url = 'https://bitbucket.org/pypa/setuptools/downloads/ez_setu
        self.install_script(context, 'setuptools', url)
        # clear up the setuptools archive which gets downloaded
        pred = lambda o: o.startswith('setuptools-') and o.endswith('.
        files = filter(pred, os.listdir(context.bin_path))
        for f in files:
            f = os.path.join(context.bin_path, f)
            os.unlink(f)

    def install_pip(self, context):
        """
        Install pip in the virtual environment.

        :param context: The information for the virtual environment
                        creation request being processed.
```

```
        """
        url = 'https://raw.github.com/pypa/pip/master/contrib/get-pip.
        self.install_script(context, 'pip', url)

def main(args=None):
    compatible = True
    if sys.version_info < (3, 3):
        compatible = False
    elif not hasattr(sys, 'base_prefix'):
        compatible = False
    if not compatible:
        raise ValueError('This script is only for use with '
                         'Python 3.3 or later')
    else:
        import argparse

        parser = argparse.ArgumentParser(prog=__name__,
                                         description='Creates virtual
                                                     'environments in
                                                     'more target '
                                                     'directories.')
        parser.add_argument('dirs', metavar='ENV_DIR', nargs='+',
                            help='A directory in which to create the
                                 'virtual environment.')
        parser.add_argument('--no-setuptools', default=False,
                            action='store_true', dest='nodist',
                            help="Don't install setuptools or pip in t
                                 "virtual environment.")
        parser.add_argument('--no-pip', default=False,
                            action='store_true', dest='nopip',
                            help="Don't install pip in the virtual "
                                 "environment.")
        parser.add_argument('--system-site-packages', default=False,
                            action='store_true', dest='system_site',
                            help='Give the virtual environment access
                                 'system site-packages dir.')
        if os.name == 'nt':
            use_symlinks = False
        else:
            use_symlinks = True
        parser.add_argument('--symlinks', default=use_symlinks,
                            action='store_true', dest='symlinks',
                            help='Try to use symlinks rather than copi
                                 'when symlinks are not the default fo
                                 'the platform.')
        parser.add_argument('--clear', default=False, action='store_tr
                            dest='clear', help='Delete the contents of
                                               'virtual environment '
                                               'directory if it alread
                                               'exists, before virtual
                                               'environment creation.'
        parser.add_argument('--upgrade', default=False, action='store_
```

```
                            dest='upgrade', help='Upgrade the virtual
                                                 'environment director
                                                 'use this version of
                                                 'Python, assuming Pyt
                                                 'has been upgraded '
                                                 'in-place.')
        parser.add_argument('--verbose', default=False, action='store_
                            dest='verbose', help='Display the output '
                                                'from the scripts which
                                                'install setuptools and
        options = parser.parse_args(args)
        if options.upgrade and options.clear:
            raise ValueError('you cannot supply --upgrade and --clear
        builder = ExtendedEnvBuilder(system_site_packages=options.syst
                                     clear=options.clear,
                                     symlinks=options.symlinks,
                                     upgrade=options.upgrade,
                                     nodist=options.nodist,
                                     nopip=options.nopip,
                                     verbose=options.verbose)
        for d in options.dirs:
            builder.create(d)

if __name__ == '__main__':
    rc = 1
    try:
        main()
        rc = 0
    except Exception as e:
        print('Error: %s' % e, file=sys.stderr)
    sys.exit(rc)
```

This script is also available for download online.