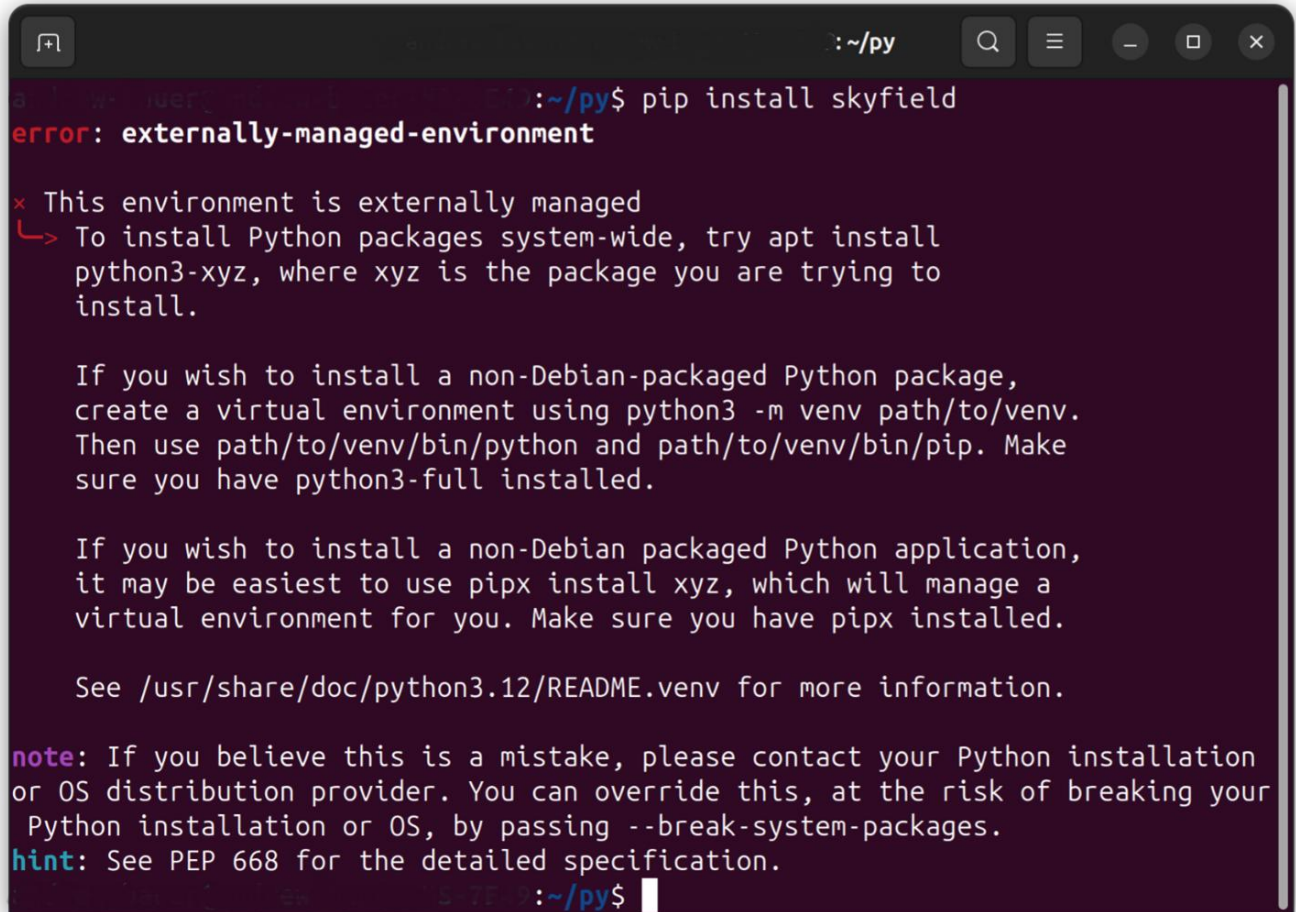


How to Install Skyalmanac on Linux

Previous versions of Linux were not critical regarding where PyPI packages are installed, however recent versions will display the following error message (which comes from Ubuntu Desktop 24.04):

A terminal window with a dark background and light-colored text. The window title bar shows a search icon, a menu icon, and window control buttons. The terminal shows a command prompt at ~/py\$ where the user has entered 'pip install skyfield'. This has resulted in an error message: 'error: externally-managed-environment'. Below the error, there is a detailed explanation in a light blue font, starting with 'x This environment is externally managed'. It suggests using 'apt install python3-xyz' for system-wide installation or creating a virtual environment with 'python3 -m venv path/to/venv'. It also mentions 'pipx install xyz' for applications. A 'note' in light red suggests contacting the OS provider if this is a mistake, and a 'hint' in light blue refers to PEP 668. The prompt returns to ~/py\$ at the bottom.

```
~/py$ pip install skyfield
error: externally-managed-environment

x This environment is externally managed
  -> To install Python packages system-wide, try apt install
      python3-xyz, where xyz is the package you are trying to
      install.

      If you wish to install a non-Debian-packaged Python package,
      create a virtual environment using python3 -m venv path/to/venv.
      Then use path/to/venv/bin/python and path/to/venv/bin/pip. Make
      sure you have python3-full installed.

      If you wish to install a non-Debian packaged Python application,
      it may be easiest to use pipx install xyz, which will manage a
      virtual environment for you. Make sure you have pipx installed.

      See /usr/share/doc/python3.12/README.venv for more information.

note: If you believe this is a mistake, please contact your Python installation
or OS distribution provider. You can override this, at the risk of breaking your
Python installation or OS, by passing --break-system-packages.
hint: See PEP 668 for the detailed specification.

~/py$
```

Basically, it is warning the user not to install packages (with their dependencies) in the global system package area. Although this can be overridden, it is bad practice to do so. In Internet there are also suggestions to use **pipx**, however **pipx** only works with applications (not with libraries, such as Skyfield – the astronomical library). The only reliable solution is to make full use of a virtual environment. The following text illustrates the recommended installation process for PyPI packages to users that may be unfamiliar with virtual environments.

A virtual environment is *good news* as then all the 'simple' pip commands work as expected (and your last installed Skyfield version is not lost). Note that none of the GitHub Skyalmanac files are required when installing packages from PyPI (the Python Package Index).

Although virtual environments are disposable in nature, they can indeed persist from session to session - they only need to be re-activated. This means that whatever you do in a virtual environment is not lost when the computer shuts down – it is only lost if the folder containing the virtual environment is deleted. Ergo – keep your virtual environment and update it with newer versions of Skyfield or Skyalmanac as they become available.

Here is a demonstration with a newly created virtual environment 'venv1'.

First create a parent folder, e.g. 'py', for all python projects including their virtual environments.

So all the action begins in the 'py' folder that's directly under 'Home'.

Then create a new virtual environment with **python -m venv <folder name>**, e.g. 'venv1' (this also creates a 'venv1' folder under 'py') - and activate it. (**python3** is equivalent to **python**)

'Activation' also prepends the command prompt with '(venv1)' – the current folder remains 'py':

```

(venv1) ~$ python3 -m venv venv1/
(venv1) ~$ source venv1/bin/activate
(venv1) ~$ pip show skyfield
WARNING: Package(s) not found: skyfield
(venv1) ~$
```

As you see, Skyfield is not installed (yet). For demonstration purposes only, install a specific Skyfield version (1.45):

```

(venv1) ~$ pip install skyfield==1.45
Collecting skyfield==1.45
  Using cached skyfield-1.45-py3-none-any.whl.metadata (2.4 kB)
Collecting certifi>=2017.4.17 (from skyfield==1.45)
  Using cached certifi-2024.8.30-py3-none-any.whl.metadata (2.2 kB)
Collecting jplephem>=2.13 (from skyfield==1.45)
  Using cached jplephem-2.22-py3-none-any.whl.metadata (22 kB)
Collecting numpy (from skyfield==1.45)
  Using cached numpy-2.1.3-cp312-cp312-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (62 kB)
Collecting sgp4>=2.2 (from skyfield==1.45)
  Using cached sgp4-2.23-cp312-cp312-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux2014_x86_64.whl.metadata (31 kB)
Using cached skyfield-1.45-py3-none-any.whl (442 kB)
Using cached certifi-2024.8.30-py3-none-any.whl (167 kB)
Using cached jplephem-2.22-py3-none-any.whl (47 kB)
Using cached sgp4-2.23-cp312-cp312-manylinux_2_5_x86_64.manylinux1_x86_64.manylinux2014_x86_64.whl (232 kB)
Using cached numpy-2.1.3-cp312-cp312-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (16.0 MB)
Installing collected packages: sgp4, numpy, certifi, jplephem, skyfield
Successfully installed certifi-2024.8.30 jplephem-2.22 numpy-2.1.3 sgp4-2.23 skyfield-1.45
(venv1) ~$
```

And verify Skyfield 1.45 is installed:

```

(venv1) ~$ pip show skyfield
Name: skyfield
Version: 1.45
Summary: Elegant astronomy for Python
Home-page: http://github.com/brandon-rhodes/python-skyfield/
Author: Brandon Rhodes
Author-email: brandon@rhodesmill.org
License: MIT
Location: /home/andrewbauer/py/venv1/lib/python3.12/site-packages
Requires: certifi, jplephem, numpy, sgp4
Required-by:
(venv1) ~$
```

It could be uninstalled with "**pip uninstall skyfield**" but upgrade it instead to the latest version with "**pip install skyfield --upgrade**" (note the double hyphens):

```
~/py
(venv1) ~$ pip install skyfield --upgrade
Requirement already satisfied: skyfield in ./venv1/lib/python3.12/site-packages (1.45)
Collecting skyfield
  Using cached skyfield-1.49-py3-none-any.whl.metadata (2.4 kB)
Requirement already satisfied: certifi>=2017.4.17 in ./venv1/lib/python3.12/site-packages (from skyfield) (2024.8.30)
Requirement already satisfied: jplephem>=2.13 in ./venv1/lib/python3.12/site-packages (from skyfield) (2.22)
Requirement already satisfied: numpy in ./venv1/lib/python3.12/site-packages (from skyfield) (2.1.3)
Requirement already satisfied: sgp4>=2.2 in ./venv1/lib/python3.12/site-packages (from skyfield) (2.23)
Using cached skyfield-1.49-py3-none-any.whl (336 kB)
Installing collected packages: skyfield
  Attempting uninstall: skyfield
    Found existing installation: skyfield 1.45
    Uninstalling skyfield-1.45:
      Successfully uninstalled skyfield-1.45
Successfully installed skyfield-1.49
(venv1) ~$
```

The current terminal session was closed and re-opened (for demonstration purposes only), and the same virtual environment is activated again from within the 'py' folder:

```
~/py
(venv1) ~$ source venv1/bin/activate
(venv1) ~$ pip show skyfield
Name: skyfield
Version: 1.49
Summary: Elegant astronomy for Python
Home-page: http://github.com/brandon-rhodes/python-skyfield/
Author: Brandon Rhodes
Author-email: brandon@rhodesmill.org
License: MIT
Location: /home/brw-bader/py/venv1/lib/python3.12/site-packages
Requires: certifi, jplephem, numpy, sgp4
Required-by:
(venv1) ~$
```

This verifies that Skyfield 1.49 is still installed.

One can also **deactivate** the virtual session and reactivate it (and Skyfield 1.49 is still there):

```
~/py
(venv1) ~$ deactivate
~$ source venv1/bin/activate
(venv1) ~$ pip show skyfield
Name: skyfield
Version: 1.49
Summary: Elegant astronomy for Python
Home-page: http://github.com/brandon-rhodes/python-skyfield/
Author: Brandon Rhodes
Author-email: brandon@rhodesmill.org
License: MIT
Location: /home/brw-bader/py/venv1/lib/python3.12/site-packages
Requires: certifi, jplephem, numpy, sgp4
Required-by:
(venv1) ~$
```


Start again with a new 'Terminal' session in the folder that contains the virtual environment(s) and activate the same VENV in which Skyfield is installed.

Note: *multiple* virtual environments can be stored in the current folder - each VENV has its own parent folder name (e.g. venv0, venv1, venv2) which is within the current folder (e.g. py).

```
~/.py$ source venv1/bin/activate
(venv1) ~$ pip show skyfield
Name: skyfield
Version: 1.49
Summary: Elegant astronomy for Python
Home-page: http://github.com/brandon-rhodes/python-skyfield/
Author: Brandon Rhodes
Author-email: brandon@rhodesmill.org
License: MIT
Location: /home/andrew-bauer/py/venv1/lib/python3.12/site-packages
Requires: certifi, jplephem, numpy, sgp4
Required-by: skyalmanac
(venv1) ~$
```

Note 'Location' above ... Skyfield is installed in a sub-folder of the virtual environment (venv1) that is currently activated.

Now install Skyalmanac (the latest version) with **pip install skyalmanac**:

```
(venv1) ~$ pip install skyalmanac
Collecting skyalmanac
  Using cached skyalmanac-1.12.4-py3-none-any.whl.metadata (7.4 kB)
Collecting Pandas (from skyalmanac)
  Using cached pandas-2.2.3-cp312-cp312-manylinux_2_17_x86_64.manylinux2014_x86_64.whl.metadata (89 kB)
Requirement already satisfied: Skyfield>=1.44 in ./venv1/lib/python3.12/site-packages (from skyalmanac) (1.49)
Requirement already satisfied: certifi>=2017.4.17 in ./venv1/lib/python3.12/site-packages (from Skyfield>=1.44->skyalmanac) (2024.8.30)
Requirement already satisfied: jplephem>=2.13 in ./venv1/lib/python3.12/site-packages (from Skyfield>=1.44->skyalmanac) (2.22)
Requirement already satisfied: numpy in ./venv1/lib/python3.12/site-packages (from Skyfield>=1.44->skyalmanac) (2.1.3)
Requirement already satisfied: sgp4>=2.2 in ./venv1/lib/python3.12/site-packages (from Skyfield>=1.44->skyalmanac) (2.23)
Requirement already satisfied: python-dateutil>=2.8.2 in ./venv1/lib/python3.12/site-packages (from Pandas->skyalmanac) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in ./venv1/lib/python3.12/site-packages (from Pandas->skyalmanac) (2024.2)
Requirement already satisfied: tzdata>=2022.7 in ./venv1/lib/python3.12/site-packages (from Pandas->skyalmanac) (2024.2)
Requirement already satisfied: six>=1.5 in ./venv1/lib/python3.12/site-packages (from python-dateutil>=2.8.2->Pandas->skyalmanac) (1.17.0)
Using cached skyalmanac-1.12.4-py3-none-any.whl (33.6 MB)
Using cached pandas-2.2.3-cp312-cp312-manylinux_2_17_x86_64.manylinux2014_x86_64.whl (12.7 MB)
Installing collected packages: Pandas, skyalmanac
Successfully installed Pandas-2.2.3 skyalmanac-1.12.4
(venv1) ~$
```

Note that it also installs 'numpy' and 'pandas' if necessary.

PyPI packages are executed using **\$ python -m <package name> <optional arguments>**

However, Skyalmanac is not yet ready to run ...

```
(venv1) ~$ python -m skyalmanac
/bin/sh: 1: tex: not found
- - - Neither TeX Live nor MiKTeX is installed - - -
(venv1) ~$
```

Tex Live needs to be installed to create the PDF files. Take care to install “**texlive-latex-extra**”. Installation begins as follows.....

```
(venv1) ~$ sudo apt install texlive-latex-extra
[sudo] password for andrew-bauer:
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  ca-certificates-java default-jre default-jre-headless dvipng fonts-dejavu-extra fonts-lato fonts-lmodern fonts-texgyre
  fonts-texgyre-math java-common libapache-pom-java libatk-wrapper-java libatk-wrapper-java-jni libbit-vector-perl libcarp-clan-perl
  libcommons-logging-java libcommons-parent-java libcrypt-rc4-perl libdate-calc-perl libdate-calc-xs-perl libdate-manip-perl
  libdigest-perl-md5-perl libfontbox-java libgumbo2 libjcode-pm-perl libmujs3 libole-storage-lite-perl libparse-recdescent-perl
  libpdfbox-java libpotrace0 libptexenc1 libruby libruby3.2 libspreadsheet-parseexcel-perl libspreadsheet-writeexcel-perl libteckit0
  libtexlua53-5 libtk8.6 libunicode-map-perl libzip-0-13t64 lmodern mupdf-tools openjdk-21-jre openjdk-21-jre-headless
  preview-latex-style rake ruby ruby-net-telnet ruby-rubygems ruby-sdbm ruby-webrick ruby-xmllrpc ruby3.2 rubygems-integration t1utils
  tex-common tex-gyre texlive-base texlive-binaries texlive-fonts-recommended texlive-latex-base texlive-latex-recommended
  texlive-pictures texlive-plain-generic tipa tk tk8.6
Suggested packages:
  libavalon-framework-java libexcalibur-logkit-java liblog4j1.2-java fonts-ipafont-gothic fonts-ipafont-mincho fonts-wqy-microhei
  | fonts-wqy-zenhei fonts-indic ri ruby-dev bundler debhelper perl-tk xzdec texlive-binaries-sse2 hintview texlive-fonts-recommended-doc
  texlive-latex-base-doc wp2latex icc-profiles libfile-which-perl texlive-latex-extra-doc texlive-science texlive-latex-recommended-doc
  texlive-luatex texlive-pstricks dot2tex prerex texlive-pictures-doc vprexer tipa-doc
The following NEW packages will be installed:
  ca-certificates-java default-jre default-jre-headless dvipng fonts-dejavu-extra fonts-lato fonts-lmodern fonts-texgyre
  fonts-texgyre-math java-common libapache-pom-java libatk-wrapper-java libatk-wrapper-java-jni libbit-vector-perl libcarp-clan-perl
  libcommons-logging-java libcommons-parent-java libcrypt-rc4-perl libdate-calc-perl libdate-calc-xs-perl libdate-manip-perl
  libdigest-perl-md5-perl libfontbox-java libgumbo2 libjcode-pm-perl libmujs3 libole-storage-lite-perl libparse-recdescent-perl
  libpdfbox-java libpotrace0 libptexenc1 libruby libruby3.2 libspreadsheet-parseexcel-perl libspreadsheet-writeexcel-perl libteckit0
  libtexlua53-5 libtk8.6 libunicode-map-perl libzip-0-13t64 lmodern mupdf-tools openjdk-21-jre openjdk-21-jre-headless
  preview-latex-style rake ruby ruby-net-telnet ruby-rubygems ruby-sdbm ruby-webrick ruby-xmllrpc ruby3.2 rubygems-integration t1utils
  tex-common tex-gyre texlive-base texlive-binaries texlive-fonts-recommended texlive-latex-base texlive-latex-extra
  texlive-latex-recommended texlive-pictures texlive-plain-generic tipa tk tk8.6
0 upgraded, 68 newly installed, 0 to remove and 41 not upgraded.
Need to get 263 MB of archives.
After this operation, 838 MB of additional disk space will be used.
Do you want to continue? [Y/n] y
Get:1 http://archive.ubuntu.com/ubuntu noble/main amd64 fonts-lato all 2.015-1 [2,781 kB]
Get:2 http://archive.ubuntu.com/ubuntu noble/main amd64 ca-certificates-java all 20240118 [11.6 kB]
Get:3 http://archive.ubuntu.com/ubuntu noble/main amd64 java-common all 0.75+exp1 [6,798 B]
Get:4 http://archive.ubuntu.com/ubuntu noble-updates/main amd64 openjdk-21-jre-headless amd64 21.0.5+11-1ubuntu1-24.04 [46.4 MB]
```

..... and eventually ends like this:

```
(venv1) ~$ sudo apt install texlive-latex-extra
Adding debian:SSL.com_TLS_ECC_Root_CA_2022.pem
Adding debian:SSL.com_TLS_RSA_Root_CA_2022.pem
Adding debian:Starfield_Class_2_CA.pem
Adding debian:Starfield_Root_Certificate_Authority_-_G2.pem
Adding debian:Starfield_Services_Root_Certificate_Authority_-_G2.pem
Adding debian:SwissSign_Gold_CA_-_G2.pem
Adding debian:SwissSign_Silver_CA_-_G2.pem
Adding debian:SZAFIR_ROOT_CA2.pem
Adding debian:Telia_Root_CA_v2.pem
Adding debian:TeliaSonera_Root_CA_v1.pem
Adding debian:TrustAsia_Global_Root_CA_G3.pem
Adding debian:TrustAsia_Global_Root_CA_G4.pem
Adding debian:Trustwave_Global_Certification_Authority.pem
Adding debian:Trustwave_Global_ECC_P256_Certification_Authority.pem
Adding debian:Trustwave_Global_ECC_P384_Certification_Authority.pem
Adding debian:T-TeleSec_GlobalRoot_Class_2.pem
Adding debian:T-TeleSec_GlobalRoot_Class_3.pem
Adding debian:TUBITAK_Kamu_SM_SSL_Kok_Sertifikasi_-_Surum_1.pem
Adding debian:TunTrust_Root_CA.pem
Adding debian:TWCA_Global_Root_CA.pem
Adding debian:TWCA_Root_Certification_Authority.pem
Adding debian:UCA_Extended_Validation_Root.pem
Adding debian:UCA_Global_G2_Root.pem
Adding debian:USERTrust_ECC_Certification_Authority.pem
Adding debian:USERTrust_RSA_Certification_Authority.pem
Adding debian:vTrus_ECC_Root_CA.pem
Adding debian:vTrus_Root_CA.pem
Adding debian:XRamp_Global_CA_Root.pem
done.
Setting up openjdk-21-jre:amd64 (21.0.5+11-1ubuntu1-24.04) ...
Setting up default-jre-headless (2:1.21-75+exp1) ...
Setting up default-jre (2:1.21-75+exp1) ...
Processing triggers for tex-common (6.18) ...
Running updmap-sys. This may take some time... done.
Running mktexlsr /var/lib/texmf ... done.
Building format(s) --all.
This may take some time... done.
(venv1) ~$
```



```

(venv1) ~$ python -m skyalmanac
Path to config.py: /home/.../py/venv1/lib/python3.12/site-packages/skyalmanac/lib/
Downloaded data in: /home/.../py/venv1/lib/python3.12/site-packages/skyalmanac/astro-data/

What do you want to create?:
 1 Nautical Almanac      (for a day/month/year)
 2 Sun tables only      (for a day/month/year)
 3 Event Time tables    (for a day/month/year)
 4 Lunar Distance tables (for a day/month/year)
 5 Lunar Distance charts (for a day/month)
 6 "Increments and Corrections" tables (static data)
1
Enter as numeric digits (or 'x' for a brief sample):
- starting date as 'DDMMYYYY'
- or just 'YYYY' (for a whole year)
- or 'YYYY-YYYY' (for first and last year)
- or just 'MM' (01 - 12) for the current or a future month
- or '-MM' for a previous month (e.g. '-02' is last February)
- or 'x' for 6 days from today
- nothing for the current day

What table style is required?:
 t Traditional
 m Modern
m
Downloading EOP data from USNO...done.

Creating the nautical almanac for 07 December 2024
execution time = 0.66 seconds
stopwatch      = 3.20 seconds
(stopwatch = time spent getting moonrise and/or moonset times)
Moonrise/moonset time seeks = 93
Above/below horizon searches = 50

This is pdfTeX, Version 3.141592653-2.6-1.40.25 (TeX Live 2023/Debian) (preloaded format=pdflatex)
restricted \write18 enabled.
entering extended mode
finished creating 'NAmod(A4)_20241207.pdf'
(venv1) ~$

```

Now Skyalmanac executed fully. The first two lines printed show the folders in which 'config.py' and the necessary astronomical data files reside. The file 'config.py' can be edited to change user options. A few questions need to be answered before Skyalmanac knows what to process.

The line "Downloading EOP data from USNO...done." refers to the file 'finals2000A.all' that contains the Earth Orientation Parameters from the International Earth Rotation and Reference Systems Service (IERS), which is one of the required astronomical data files. It only needs to be downloaded occasionally. The PDF output file appears in your current folder [which otherwise only contains your virtual environment folder(s)].

Operation	Command
Create a virtual environment (and its folder)	\$ python -m venv <VENV folder>
Activate the virtual environment	\$ source <VENV folder>/bin/activate
Deactivate the virtual environment	\$ deactivate
Show the installed package version (if any)	\$ pip show <package name>
Install the latest version if a package	\$ pip install <package name>
Install an older package version	\$ pip install <package name>==<version>
Uninstall a package	\$ pip uninstall <package name>
Upgrade a package to the latest version	\$ pip install <package name> --upgrade
Execute an installed package (from PyPI)	\$ python -m <package name> <options>