

PyHelpers

An open-source toolkit for facilitating Python users' data manipulation tasks

Release 1.3.3

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First release: September 2019

Last updated: May 2022

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Chapter 1

About PyHelpers

PyHelpers is an open-source Python package designed as a lite toolkit for facilitating data (pre)processing. It offers a miscellaneous collection of handy utilities, which could assist with performing many common data manipulation tasks, such as reading/writing of file-like objects, handling of various types of data (e.g. geographical data and textual data) and communication with relational databases (e.g. PostgreSQL).

Chapter 2

Installation

To install the latest release of pyhelpers from [PyPI](#) via `pip`:

```
pip install --upgrade pyhelpers
```

To install the most recent version of pyhelpers hosted on [GitHub](#):

```
pip install --upgrade git+https://github.com/mikeqfu/pyhelpers.git
```

Note:

- If using a [virtual environment](#), make sure it is activated.
 - It is recommended to add `pip install` the option `--upgrade` (or `-U`) to ensure that you are getting the latest stable release of the package.
 - Not all dependencies of pyhelpers are enforced to be installed along with the installation of the package. This is intended to optimise the installation requirements. If a [ModuleNotFoundError](#) or an [ImportError](#) pops out when importing/running a function, first try to install the module(s)/package(s) mentioned in the error message, and then try importing/running the function again.
 - For Windows users, `pip` may possibly fail to install some packages. In such circumstances, try instead to [install their .whl files](#), which can be downloaded from the web page of the [unofficial Windows binaries for Python extension packages](#).
 - For more general instructions on the installation of Python packages, please refer to the official guide of [Installing Packages](#).
-

To check whether pyhelpers has been correctly installed, try to import the package via an interpreter shell:

```
>>> import pyhelpers
>>> pyhelpers.__version__ # Check the latest version
```

The latest version is: 1.3.3

Chapter 3

Modules

The current release includes the following modules, with each containing a number of utilities:

<i>settings</i>	Settings of working environment.
<i>dir</i>	Manipulation of directories and/or file paths.
<i>ops</i>	Miscellaneous operations.
<i>store</i>	Saving, loading and other relevant operations of file-like objects.
<i>geom</i>	Manipulation of geometric/geographical data.
<i>text</i>	Manipulation of textual data.
<i>dbms</i>	Communication with databases.

3.1 settings

Settings of working environment.

3.1.1 Configurations

GDAL/OGR

<i>gdal_configurations</i> ([reset, ...])	Alter some default configuration options of GDAL/OGR drivers.
---	---

gdal_configurations

```
pyhelpers.settings.gdal_configurations(reset=False, max_tmpfile_size=5000,  
                                       interleaved_reading=True, custom_indexing=False,  
                                       compress_nodes=True)
```

Alter some default [configuration options](#) of GDAL/OGR drivers.

Parameters

- **reset** (*bool*) – whether to reset to default settings, defaults to False
- **max_tmpfile_size** (*int*) – maximum size of the temporary file, defaults to 5000
- **interleaved_reading** (*bool*) – whether to enable interleaved reading, defaults to True
- **custom_indexing** (*bool*) – whether to enable custom indexing, defaults to False
- **compress_nodes** (*bool*) – whether to compress nodes in temporary DB, defaults to True

Examples:

```
>>> from pyhelpers.settings import gdal_configurations  
>>> gdal_configurations()
```

Note: This can be useful when using [GDAL](#) to parse a large PBF file. For example, `gdal_configurations()` is applied by default when importing the package [pydriosm](#), which can be used to work with [OpenStreetMap](#) data of [PBF format](#).

See also:

- [OpenStreetMap XML and PBF](#)
- [pydriosm Documentation](#)

3.1.2 Preferences

Matplotlib

<code>mpl_preferences([reset, font_name, ...])</code>	Alter some Matplotlib parameters .
---	--

mpl_preferences

`pyhelpers.settings.mpl_preferences(reset=False, font_name='Times New Roman', font_size=13, legend_spacing=0.7, fig_style=None)`

Alter some [Matplotlib parameters](#).

Parameters

- **font_name** (*None* or *str*) – name of a font to be used, defaults to 'Times New Roman'
- **font_size** (*int* or *float*) – font size, defaults to 13
- **legend_spacing** (*float* or *int*) – spacing between labels in plot legend, defaults to 0.7
- **fig_style** (*str* or *None*) – style of the figure, defaults to *None*
- **reset** (*bool*) – whether to reset to default settings, defaults to *False*

Examples:

```
>>> import numpy as np
>>> import matplotlib.pyplot as plt

>>> np.random.seed(0)

>>> random_array = np.random.rand(1000, 2)
>>> random_array
array([[0.5488135 , 0.71518937],
       [0.60276338, 0.54488318],
       [0.4236548 , 0.64589411],
       ...,
       [0.41443887, 0.79128155],
       [0.72119811, 0.48010781],
       [0.64386404, 0.50177313]])

>>> def example_plot(arr):
...     fig = plt.figure(figsize=(6, 6))
...     ax = fig.add_subplot(aspect='equal', adjustable='box')
...
...     ax.scatter(arr[:500, 0], arr[:500, 1], label='Group0')
...     ax.scatter(arr[500:, 0], arr[500:, 1], label='Group1')
...     ax.legend(loc='best')
...
...     plt.tight_layout()
...
...     plt.show()

>>> example_plot(random_array)
```

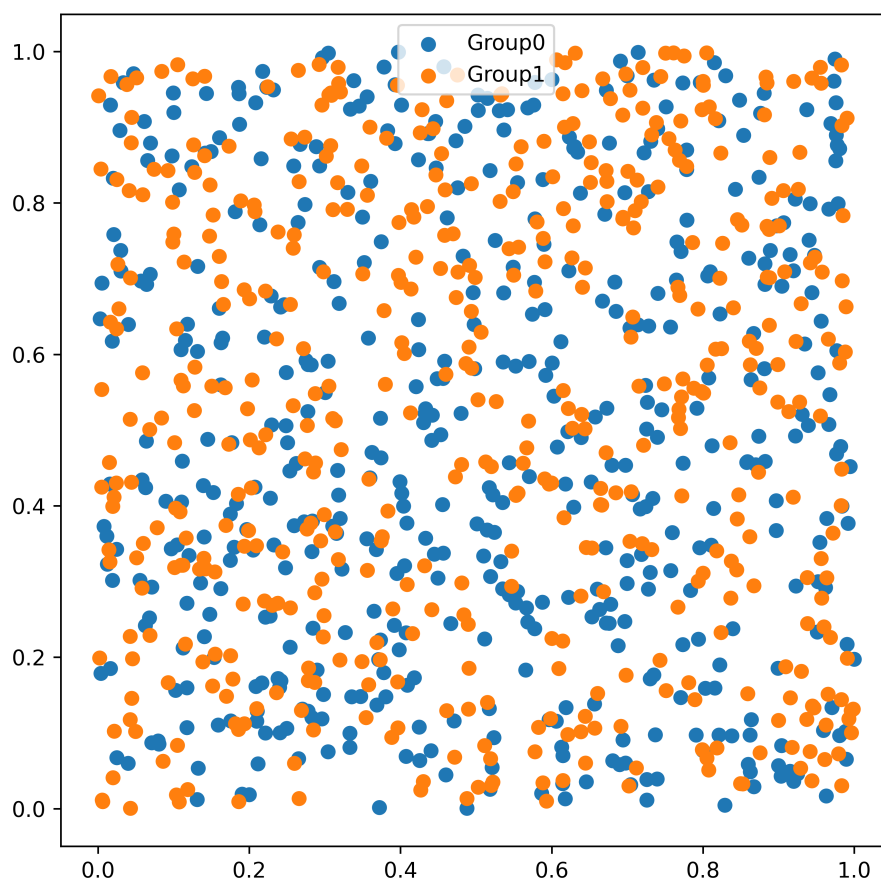


Fig. 1: An example figure, before applying the function `mpl_preferences()`.

```
>>> from pyhelpers.settings import mpl_preferences
>>> mpl_preferences(fig_style='ggplot')
>>> example_plot(random_array)
```

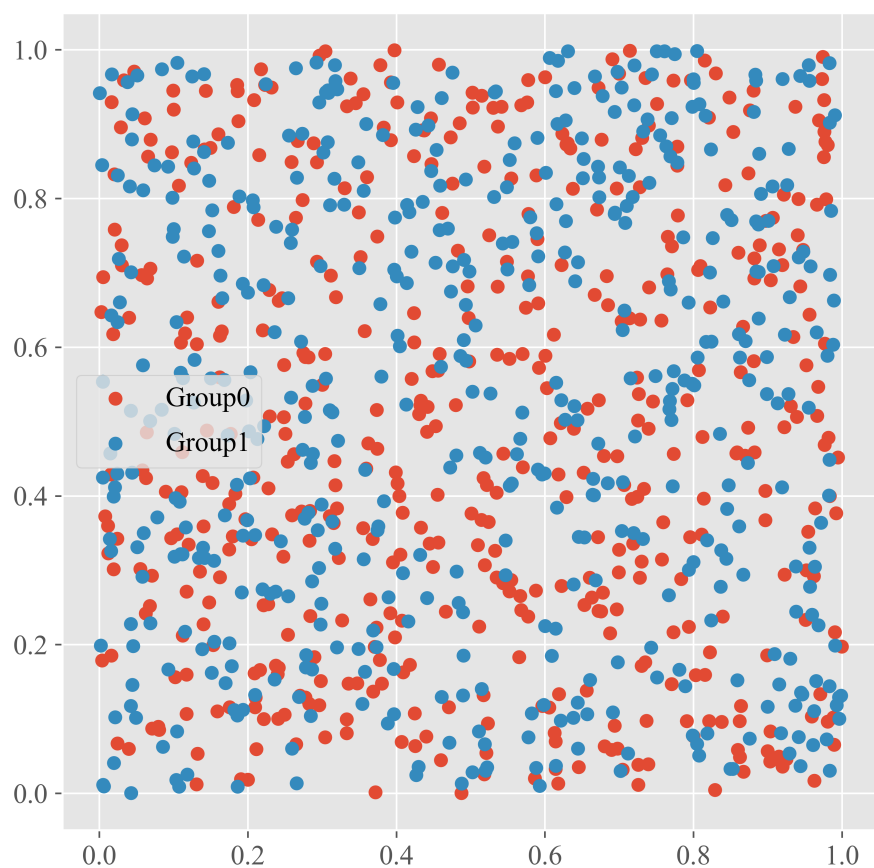


Fig. 2: After applying the function `mpl_preferences()`.

Reset to default settings:

```
>>> mpl_preferences(reset=True)
>>> example_plot(random_array)
```

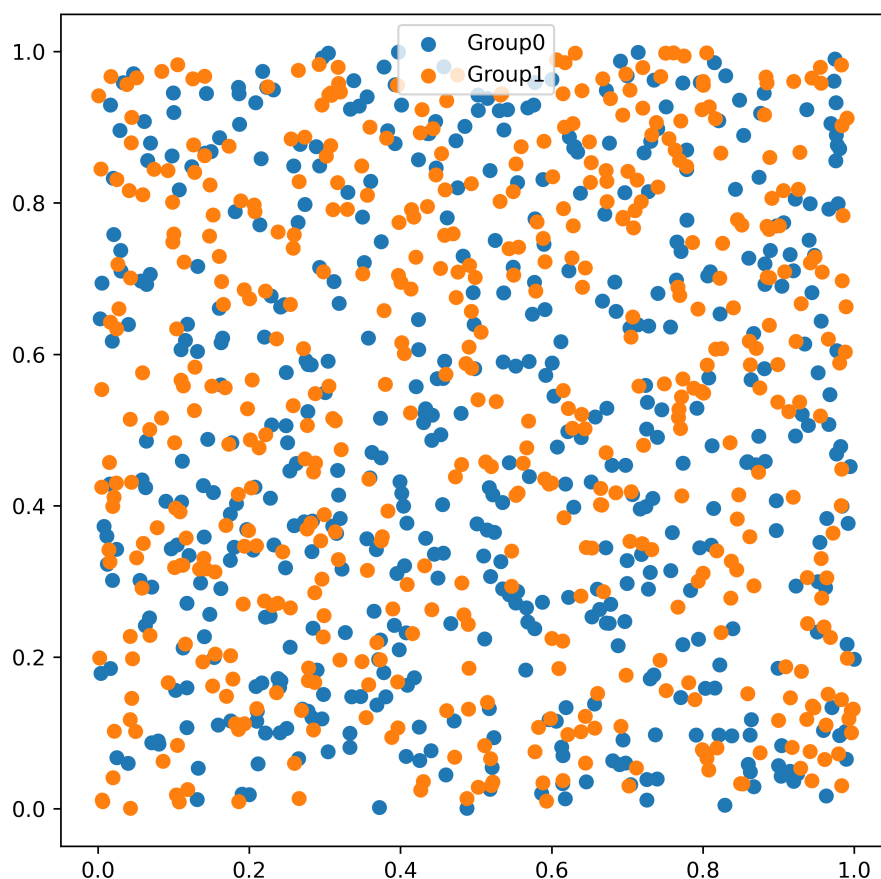


Fig. 3: Resetting the altered parameters to their default values.

NumPy

<code>np_preferences([reset, precision, ...])</code>	Alter some default parameters for displaying NumPy arrays.
--	--

np_preferences

```
pyhelpers.settings.np_preferences(reset=False, precision=4, head_tail=5, line_char=120,
                                   formatter=None, **kwargs)
```

Alter some default parameters for displaying NumPy arrays.

Parameters

- **reset** (*bool*) – whether to reset to the default print options set by `numpy.set_printoptions()`, defaults to `False`
- **precision** (*int*) – number of decimal points, which corresponds to precision of `numpy.set_printoptions()`, defaults to `4`

- **line_char** (*int*) – number of characters per line for the purpose of inserting line breaks, which corresponds to `linewidth` of `numpy.set_printoptions()`, defaults to 120
- **head_tail** (*int*) – number of array items in summary at beginning (head) and end (tail) of each dimension, which corresponds to `edgeitems` of `numpy.set_printoptions()`, defaults to 5
- **formatter** (*dict or None*) – specified format, which corresponds to `formatter` of `numpy.set_printoptions()`, if `None` (default), fill the empty decimal places with zeros for the specified precision

Kwargs [optional] parameters used by `numpy.set_printoptions()`

Examples:

```
>>> import numpy as np

>>> np.random.seed(0)

>>> random_array = np.random.rand(100, 100)
>>> random_array
array([[0.5488135 , 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.5736796 , 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.1419334 ],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
        0.81357508]])

>>> from pyhelpers.settings import np_preferences

>>> np_preferences(precision=2)

>>> random_array
array([[0.55, 0.72, 0.60, 0.54, 0.42, ..., 0.18, 0.59, 0.02, 0.83, 0.00],
       [0.68, 0.27, 0.74, 0.96, 0.25, ..., 0.49, 0.23, 0.25, 0.06, 0.43],
       [0.31, 0.70, 0.38, 0.18, 0.02, ..., 0.22, 0.10, 0.86, 0.97, 0.96],
       [0.91, 0.77, 0.33, 0.08, 0.41, ..., 0.96, 0.36, 0.36, 0.02, 0.19],
       [0.40, 0.93, 0.10, 0.95, 0.87, ..., 0.27, 0.46, 0.40, 0.25, 0.51],
       ...,
       [0.03, 0.99, 0.09, 0.45, 0.84, ..., 0.12, 0.29, 0.37, 0.91, 0.14],
       [0.62, 0.20, 0.29, 0.45, 0.55, ..., 0.48, 0.87, 0.22, 0.14, 0.93],
       [0.89, 0.27, 0.84, 0.76, 1.00, ..., 0.98, 0.41, 0.57, 0.74, 0.23],
       [0.27, 0.74, 0.81, 0.20, 0.31, ..., 0.51, 0.23, 0.95, 0.88, 0.14],
       [0.88, 0.20, 0.57, 0.93, 0.56, ..., 0.55, 0.40, 0.76, 0.02, 0.81]])
```

Reset to default settings:

```
>>> np_preferences(reset=True)
```

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```
>>> random_array
array([[0.54881350, 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.57367960, 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.14193340],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
        0.81357508]])
```

Pandas

<code>pd_preferences([reset, max_columns, ...])</code>	Alter parameters of some frequently-used Pandas options and settings for displaying data frame.
--	---

pd_preferences

`pyhelpers.settings.pd_preferences(reset=False, max_columns=100, max_rows=20, precision=4, east_asian_text=False, ignore_future_warning=True)`

Alter parameters of some frequently-used Pandas options and settings for displaying data frame.

Parameters

- **reset** (*bool or str*) – whether to reset all to default settings, defaults to False
- **max_columns** (*int*) – maximum number of columns, which corresponds to 'display.max_columns' for `pandas.set_option()`, defaults to 100
- **max_rows** (*int*) – maximum number of rows, which corresponds to 'display.max_rows' for `pandas.set_option()`, defaults to 20
- **precision** (*int*) – number of decimal places, which corresponds to 'display.precision' for `pandas.set_option()`, defaults to 4
- **east_asian_text** (*bool*) – whether to adjust the display for east asian texts, defaults to False
- **ignore_future_warning** (*bool*) – whether to ignore/suppress future warnings, defaults to True

Examples:

```
>>> import numpy as np
>>> import pandas as pd

>>> np.random.seed(0)

>>> random_array = np.random.rand(100, 100)

>>> data_frame = pd.DataFrame(random_array)
>>> data_frame
```

	0	1	2	...	97	98	99
0	0.548814	0.715189	0.602763	...	0.020108	0.828940	0.004695
1	0.677817	0.270008	0.735194	...	0.254356	0.058029	0.434417
2	0.311796	0.696343	0.377752	...	0.862192	0.972919	0.960835
3	0.906555	0.774047	0.333145	...	0.356707	0.016329	0.185232
4	0.401260	0.929291	0.099615	...	0.401714	0.248413	0.505866
..
95	0.029929	0.985128	0.094747	...	0.369907	0.910011	0.142890
96	0.616935	0.202908	0.288809	...	0.215006	0.143577	0.933162
97	0.891112	0.268674	0.840285	...	0.573680	0.737291	0.225198
98	0.269698	0.738825	0.807145	...	0.948368	0.881307	0.141933
99	0.884982	0.197014	0.568613	...	0.758430	0.023787	0.813575

```
[100 rows x 100 columns]
```

Limit to display of at most 6 columns and round the numbers to 2 decimal places:

```
>>> from pyhelpers.settings import pd_preferences

>>> pd_preferences(max_columns=6, precision=2)

>>> data_frame
```

	0	1	2	...	97	98	99
0	0.55	0.72	0.60	...	0.02	0.83	0.00
1	0.68	0.27	0.74	...	0.25	0.06	0.43
2	0.31	0.70	0.38	...	0.86	0.97	0.96
3	0.91	0.77	0.33	...	0.36	0.02	0.19
4	0.40	0.93	0.10	...	0.40	0.25	0.51
..
95	0.03	0.99	0.09	...	0.37	0.91	0.14
96	0.62	0.20	0.29	...	0.22	0.14	0.93
97	0.89	0.27	0.84	...	0.57	0.74	0.23
98	0.27	0.74	0.81	...	0.95	0.88	0.14
99	0.88	0.20	0.57	...	0.76	0.02	0.81

```
[100 rows x 100 columns]
```

Reset to default settings:

```
>>> pd_preferences(reset=True)

>>> data_frame
```

	0	1	2	...	97	98	99
0	0.548814	0.715189	0.602763	...	0.020108	0.828940	0.004695
1	0.677817	0.270008	0.735194	...	0.254356	0.058029	0.434417
2	0.311796	0.696343	0.377752	...	0.862192	0.972919	0.960835
3	0.906555	0.774047	0.333145	...	0.356707	0.016329	0.185232
4	0.401260	0.929291	0.099615	...	0.401714	0.248413	0.505866

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```

..      ...      ...      ...      ...      ...      ...
95  0.029929  0.985128  0.094747  ...  0.369907  0.910011  0.142890
96  0.616935  0.202908  0.288809  ...  0.215006  0.143577  0.933162
97  0.891112  0.268674  0.840285  ...  0.573680  0.737291  0.225198
98  0.269698  0.738825  0.807145  ...  0.948368  0.881307  0.141933
99  0.884982  0.197014  0.568613  ...  0.758430  0.023787  0.813575

[100 rows x 100 columns]

```

Note:

- Default values of all available options can be checked by running `pandas.describe_option()` or `pandas._config.config._registered_options`

3.2 dir

Manipulation of directories and/or file paths.

3.2.1 Directory navigation

<code>cd(*subdir[, mkdir, cwd, back_check])</code>	Get the full pathname of a directory (or file).
<code>go_from_altered_cwd(dir_name, **kwargs)</code>	Get the full pathname of an altered working directory.
<code>cdd(*subdir[, data_dir, mkdir])</code>	Get the full pathname of a directory (or file) under <code>data_dir</code> .
<code>cd_data(*subdir[, data_dir, mkdir])</code>	Get the full pathname of a directory (or file) under <code>data_dir</code> of a package.

cd

`pyhelpers.dir.cd(*subdir, mkdir=False, cwd=None, back_check=False, **kwargs)`

Get the full pathname of a directory (or file).

Parameters

- **subdir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of a directory or names of directories (and/or a filename)
- **mkdir** (*bool*) – whether to create a directory, defaults to `False`
- **cwd** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]* or *None*) – current working directory, defaults to `None`
- **back_check** (*bool*) – whether to check if a parent directory exists, defaults to `False`

- **kwargs** – [optional] parameters (e.g. `mode=0o777`) of `os.makedirs`

Returns full pathname of a directory or that of a file

Return type `str`

Examples:

```
>>> from pyhelpers.dir import cd
>>> import os
>>> import pathlib

>>> current_wd = cd() # Current working directory
>>> os.path.relpath(current_wd)
'.'

>>> # The directory will be created if it does not exist
>>> path_to_tests_dir = cd("tests")
>>> os.path.relpath(path_to_tests_dir)
'tests'

>>> path_to_tests_dir = cd(pathlib.Path("tests"))
>>> os.path.relpath(path_to_tests_dir)
'tests'
```

go_from_altered_cwd

`pyhelpers.dir.go_from_altered_cwd(dir_name, **kwargs)`

Get the full pathname of an altered working directory.

Parameters

- **dir_name** (`str` or `os.PathLike[str]` or `bytes` or `os.Path[bytes]`)
– name of a directory
- **kwargs** – [optional] parameters of the function `pyhelpers.dir.cd()`

Returns full pathname of an altered working directory (changed from the directory `dir_name`)

Return type `str`

Examples:

```
>>> from pyhelpers.dir import go_from_altered_cwd
>>> import os

>>> cwd = os.getcwd()
>>> cwd
'<cwd>'

>>> # If the current working directory has been altered to "<cwd>\test", and
>>> # we'd like to set it to be "<cwd>\target"
>>> a_cwd = go_from_altered_cwd(dir_name="target")
>>> a_cwd
'<cwd>\target'
```

cdd

`pyhelpers.dir.cdd(*subdir, data_dir='data', mkdir=False, **kwargs)`

Get the full pathname of a directory (or file) under `data_dir`.

Parameters

- **subdir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of directory or names of directories (and/or a filename)
- **data_dir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of a directory where data is (or will be) stored, defaults to "data"
- **mkdir** (*bool*) – whether to create a directory, defaults to False
- **kwargs** – [optional] parameters of the function `pyhelpers.dir.cd()`

Return path full pathname of a directory (or a file) under `data_dir`

Return type *str*

Examples:

```
>>> from pyhelpers.dir import cdd, delete_dir
>>> import os

>>> path_to_dat_dir = cdd()
>>> # As `mkdir=False`, `path_to_dat_dir` will NOT be created if it doesn't exist
>>> os.path.relpath(path_to_dat_dir)
'data'

>>> path_to_dat_dir = cdd(data_dir="test_cdd", mkdir=True)
>>> # As `mkdir=True`, `path_to_dat_dir` will be created if it doesn't exist
>>> os.path.relpath(path_to_dat_dir)
'test_cdd'

>>> # Delete the "test_cdd" folder
>>> delete_dir(path_to_dat_dir, verbose=True)
To delete the directory "test_cdd\"
? [No]|Yes: yes
Deleting "test_cdd\" ... Done.

>>> # Set `data_dir` to be `"tests"`
>>> path_to_dat_dir = cdd("data", data_dir="test_cdd", mkdir=True)
>>> os.path.relpath(path_to_dat_dir)
'test_cdd\data'

>>> # Delete the "test_cdd" folder and the sub-folder "data"
>>> test_cdd = os.path.dirname(path_to_dat_dir)
>>> delete_dir(test_cdd, verbose=True)
The directory "test_cdd\" is not empty.
Confirmed to delete it
? [No]|Yes: yes
Deleting "test_cdd\" ... Done.

>>> # # Alternatively,
>>> # import shutil
>>> # shutil.rmtree(test_cdd)
```

cd_data

`pyhelpers.dir.cd_data(*subdir, data_dir='data', mkdir=False, **kwargs)`

Get the full pathname of a directory (or file) under `data_dir` of a package.

Parameters

- **subdir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of directory or names of directories (and/or a filename)
- **data_dir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of a directory to store data, defaults to "data"
- **mkdir** (*bool*) – whether to create a directory, defaults to `False`
- **kwargs** – [optional] parameters (e.g. `mode=0o777`) of `os.makedirs`

Returns full pathname of a directory or that of a file under `data_dir` of a package

Return type `str`

Examples:

```
>>> from pyhelpers.dir import cd_data
>>> import os

>>> path_to_dat_dir = cd_data("tests", mkdir=False)

>>> os.path.relpath(path_to_dat_dir)
'src\pyhelpers\data\tests'
```

3.2.2 Directory validation

<code>is_dir(path_to_dir)</code>	Check whether a directory-like string is a directory name.
<code>validate_dir([path_to_dir, subdir, msg])</code>	Validate the pathname of a directory.

is_dir

`pyhelpers.dir.is_dir(path_to_dir)`

Check whether a directory-like string is a directory name.

Parameters `path_to_dir` (*str* or *bytes*) – name of a directory

Returns whether the input is a path-like string that describes a directory name

Return type `bool`

Examples:

```
>>> from pyhelpers.dir import cd, is_dir

>>> x = "tests"
>>> is_dir(x)
False

>>> x = "/tests"
>>> is_dir(x)
True

>>> x = cd("tests")
>>> is_dir(x)
True
```

validate_dir

`pyhelpers.dir.validate_dir(path_to_dir=None, subdir='', msg='Invalid input!', **kwargs)`

Validate the pathname of a directory.

Parameters

- **path_to_dir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]* or *None*) – pathname of a data directory, defaults to *None*
- **subdir** (*str* or *os.PathLike[str]* or *bytes* or *os.Path[bytes]*) – name of a subdirectory to be examined if *directory=None*, defaults to *""*
- **msg** (*str*) – error message if *data_dir* is not a full pathname, defaults to *"Invalid input!"*
- **kwargs** – [optional] parameters of the function `pyhelpers.dir.cd()`

Returns valid full pathname of a directory

Return type *str*

Examples:

```
>>> from pyhelpers.dir import validate_dir
>>> import os

>>> dat_dir = validate_dir()
>>> os.path.relpath(dat_dir)
'.'

>>> dat_dir = validate_dir("tests")
>>> os.path.relpath(dat_dir)
'tests'

>>> dat_dir = validate_dir(subdir="data")
>>> os.path.relpath(dat_dir)
'data'
```

3.2.3 Directory removal

<code>delete_dir(path_to_dir[, ...])</code>	Delete a directory or directories.
---	------------------------------------

`delete_dir`

`pyhelpers.dir.delete_dir(path_to_dir, confirmation_required=True, verbose=False, **kwargs)`

Delete a directory or directories.

Parameters

- **path_to_dir** (*str* or *bytes* or *os.PathLike[str]* or *os.PathLike[bytes]* or *collections.abc.Sequence*) – pathname (or pathnames) of a directory (or directories)
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to `True`
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to `False`
- **kwargs** – [optional] parameters of `shutil.rmtree` or `os.rmdir`

Examples:

```
>>> from pyhelpers.dir import cd, delete_dir
>>> import os

>>> test_dirs = []
>>> for x in range(3):
...     test_dirs.append(cd("tests", f"test_dir{x}", mkdir=True))
...     if x == 0:
...         cd("tests", f"test_dir{x}", "a_folder", mkdir=True)
...     elif x == 1:
...         open(cd("tests", f"test_dir{x}", "file"), 'w').close()

>>> delete_dir(path_to_dir=test_dirs, verbose=True)
To delete the following directories:
    "tests\test_dir0\" (Not empty)
    "tests\test_dir1\" (Not empty)
    "tests\test_dir2\"
? [No]|Yes: yes
Deleting "tests\test_dir0\" ... Done.
Deleting "tests\test_dir1\" ... Done.
Deleting "tests\test_dir2\" ... Done.
```

3.3 ops

Miscellaneous operations.

3.3.1 General use

<code>confirmed([prompt, confirmation_required, resp])</code>	Type to confirm whether to proceed or not.
<code>get_obj_attr(obj[, col_names, as_dataframe])</code>	Get main attributes of an object.
<code>eval_dtype(str_val)</code>	Convert a string to its intrinsic data type.
<code>gps_to_utc(gps_time)</code>	Convert standard GPS time to UTC time.
<code>parse_size(size[, binary, precision])</code>	Parse size from / into readable format of bytes.
<code>get_number_of_chunks(file_or_obj[, ...])</code>	Get total number of chunks of a data file, given a minimum limit of chunk size.
<code>find_executable(app_name[, possibilities])</code>	Get pathname of an executable file for a specified application.
<code>hash_password(password[, salt, salt_size, ...])</code>	Hash a password using hashlib.pbkdf2_hmac .
<code>verify_password(password, salt, key[, ...])</code>	Verify a password given salt and key.

confirmed

`pyhelpers.ops.confirmed(prompt=None, confirmation_required=True, resp=False)`

Type to confirm whether to proceed or not.

See also [OPS-C-1].

Parameters

- **prompt** (*str* or *None*) – a message that prompts a response (Yes/No), defaults to *None*
- **confirmation_required** (*bool*) – whether to require users to confirm and proceed, defaults to *True*
- **resp** (*bool*) – default response, defaults to *False*

Returns a response

Return type *bool*

Examples:

```
>>> from pyhelpers.ops import confirmed

>>> if confirmed(prompt="Testing if the function works?", resp=True):
...     print("Passed.")
Testing if the function works? [Yes]|No: yes
Passed.
```

get_obj_attr

`pyhelpers.ops.get_obj_attr(obj, col_names=None, as_dataframe=False)`

Get main attributes of an object.

Parameters

- **obj** (*object*) – an object, e.g. a class
- **col_names** (*list*) – a list of column names
- **as_dataframe** (*bool*) – whether to return the data in tabular format, defaults to False

Returns list or tabular data of the main attributes of the given object

Return type `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.ops import get_obj_attr
>>> from pyhelpers.dbms import PostgreSQL

>>> postgres = PostgreSQL()
Password (postgres@localhost:5432): ***
Connecting postgres:***@localhost:5432/postgres ... Successfully.

>>> obj_attr = get_obj_attr(postgres, as_dataframe=True)
>>> obj_attr.head()
   attribute      value
0  DEFAULT_DATABASE  postgres
1  DEFAULT_DIALECT  postgresql
2  DEFAULT_DRIVER   psycopg2
3  DEFAULT_HOST     localhost
4  DEFAULT_PORT      5432

>>> obj_attr.Attribute.to_list()
['DEFAULT_DATABASE',
 'DEFAULT_DIALECT',
 'DEFAULT_DRIVER',
 'DEFAULT_HOST',
 'DEFAULT_PORT',
 'DEFAULT_SCHEMA',
 'DEFAULT_USERNAME',
 'address',
 'database_info',
 'database_name',
 'engine',
 'host',
 'port',
 'url',
 'username']
```

eval_dtype

`pyhelpers.ops.eval_dtype(str_val)`

Convert a string to its intrinsic data type.

Parameters `str_val` (*str*) – a string-type variable

Returns converted value

Return type any

Examples:

```
>>> from pyhelpers.ops import eval_dtype

>>> val_1 = '1'
>>> origin_val = eval_dtype(val_1)
>>> origin_val
1

>>> val_2 = '1.1.1'
>>> origin_val = eval_dtype(val_2)
>>> origin_val
'1.1.1'
```

gps_to_utc

`pyhelpers.ops.gps_to_utc(gps_time)`

Convert standard GPS time to UTC time.

Parameters `gps_time` (*float*) – standard GPS time

Returns UTC time

Return type `datetime.datetime`

Examples:

```
>>> from pyhelpers.ops import gps_to_utc

>>> utc_dt = gps_to_utc(gps_time=1271398985.7822514)
>>> utc_dt
datetime.datetime(2020, 4, 20, 6, 23, 5, 782251)
```

parse_size

`pyhelpers.ops.parse_size(size, binary=True, precision=1)`

Parse size from / into readable format of bytes.

Parameters

- **size** (*str or int or float*) – human- or machine-readable format of size

- **binary** (*bool*) – whether to use binary (i.e. factorized by 1024) representation, defaults to True; if binary=False, use the decimal (or metric) representation (i.e. factorized by 10^{**3})
- **precision** (*int*) – number of decimal places (when converting size to human-readable format), defaults to 1

Returns parsed size

Return type int or str

Examples:

```
>>> from pyhelpers.ops import parse_size

>>> parse_size(size='123.45 MB')
129446707

>>> parse_size(size='123.45 MB', binary=False)
123450000

>>> parse_size(size='123.45 MiB', binary=True)
129446707
>>> # If a metric unit (e.g. 'MiB') is specified in the input,
>>> # the function returns a result accordingly, no matter whether `binary` is True or False
>>> parse_size(size='123.45 MiB', binary=False)
129446707

>>> parse_size(size=129446707, precision=2)
'123.45 MiB'

>>> parse_size(size=129446707, binary=False, precision=2)
'129.45 MB'
```

get_number_of_chunks

`pyhelpers.ops.get_number_of_chunks(file_or_obj, chunk_size_limit=50, binary=True)`

Get total number of chunks of a data file, given a minimum limit of chunk size.

Parameters

- **file_or_obj** (*str*) – absolute path to a file
- **chunk_size_limit** (*int*) – the minimum limit of file size (in mebibyte i.e. MiB, or megabyte, i.e. MB) above which the function counts how many chunks there could be, defaults to 50;
- **binary** (*bool*) – whether to use binary (i.e. factorized by 1024) representation, defaults to True; if binary=False, use the decimal (or metric) representation (i.e. factorized by 10^{**3})

Returns number of chunks

Return type int or None

Examples:

```
>>> from pyhelpers.ops import get_number_of_chunks
>>> import os

>>> file_path = "C:\\Program Files\\Python39\\python39.pdb"

>>> os.path.getsize(file_path)
13611008
>>> get_number_of_chunks(file_path, chunk_size_limit=2)
7
```

find_executable

pyhelpers.ops.find_executable(*app_name*, *possibilities=None*)

Get pathname of an executable file for a specified application.

Parameters

- **app_name** (*str*) – executable filename of the application that is to be called
- **possibilities** (*list or set or None*) – possible pathnames

Returns pathname of the specified executable file and whether it exists

Return type *Tuple*[*str*, *bool*]

Examples:

```
>>> from pyhelpers.ops import find_executable
>>> import os

>>> python_exe = "python.exe"
>>> possible_paths = ["C:\\Program Files\\Python39", "C:\\Python39"]

>>> path_to_python_exe, python_exe_exists = find_executable(python_exe, possible_paths)
>>> os.path.relpath(path_to_python_exe)
'venv\\Scripts\\python.exe'
>>> python_exe_exists
True

>>> text_exe = "pyhelpers.exe" # This file does not actually exist
>>> path_to_test_exe, test_exe_exists = find_executable(text_exe, possible_paths)
>>> path_to_test_exe
'pyhelpers.exe'
>>> test_exe_exists
False
```

hash_password

`pyhelpers.ops.hash_password(password, salt=None, salt_size=None, iterations=None, ret_hash=True, **kwargs)`

Hash a password using `hashlib.pbkdf2_hmac`.

See also [OPS-HP-1].

Parameters

- **password** (*str or int or float*) – input as a password
- **salt** (*bytes or str*) – random data; when `salt=None` (default), it is generated by `os.urandom()`, which depends on `salt_size`; see also [OPS-HP-2]
- **salt_size** (*int or None*) – size of the function `os.urandom()`, i.e. the size of a random bytestring for cryptographic use; when `salt_size=None` (default), it uses 128
- **iterations** (*int or None*) – size of the function `hashlib.pbkdf2_hmac()`, i.e. number of iterations of SHA-256; when `salt_size=None` (default), it uses 100000
- **ret_hash** (*bool*) – whether to return the salt and key, defaults to `True`
- **kwargs** – [optional] parameters of the function `hashlib.pbkdf2_hmac()`

Returns (only when `ret_hash=True`) salt and key

Return type bytes

Examples:

```
>>> from pyhelpers.ops import hash_password, verify_password

>>> sk = hash_password('test%123', salt_size=16) # salt and key

>>> salt_data = sk[:16].hex()
>>> key_data = sk[16:].hex()

>>> verify_password('test%123', salt=salt_data, key=key_data)
True
```

verify_password

`pyhelpers.ops.verify_password(password, salt, key, iterations=None)`

Verify a password given salt and key.

Parameters

- **password** (*str or int or float*) – input as a password
- **salt** (*bytes or str*) – random data; see also [OPS-HP-1]

- **key** (*bytes* or *str*) – PKCS#5 password-based key (produced by the function `hashlib.pbkdf2_hmac()`)
- **iterations** (*int* or *None*) – size of the function `hashlib.pbkdf2_hmac()`, i.e. number of iterations of SHA-256; when `salt_size=None` (default), it uses 100000

Returns whether the input password is correct

Return type bool

See also:

- Examples of the function `pyhelpers.ops.hash_password()`

3.3.2 Basic data manipulation

Iterable

<code>loop_in_pairs(iterable)</code>	Get every pair (current, next).
<code>split_list_by_size(lst, sub_len)</code>	Split a list into (evenly sized) sub-lists.
<code>split_list(lst, num_of_sub)</code>	Split a list into a number of equally-sized sub-lists.
<code>split_iterable(iterable, chunk_size)</code>	Split a list into (evenly sized) chunks.
<code>update_dict(dictionary, updates[, inplace])</code>	Update a (nested) dictionary or similar mapping.
<code>update_dict_keys(dictionary[, replacements])</code>	Update keys in a (nested) dictionary.
<code>get_dict_values(key, dictionary)</code>	Get all values in a (nested) dictionary for a given key.
<code>remove_dict_keys(dictionary, *keys)</code>	Remove multiple keys from a dictionary.
<code>compare_dicts(dict1, dict2)</code>	Compare the difference between two dictionaries.
<code>merge_dicts(*dicts)</code>	Merge multiple dictionaries.

loop_in_pairs

`pyhelpers.ops.loop_in_pairs(iterable)`

Get every pair (current, next).

Parameters `iterable` (*Iterable*) – iterable object

Returns a `zip`-type variable

Return type `zip`

Examples:

```
>>> from pyhelpers.ops import loop_in_pairs

>>> res = loop_in_pairs(iterable=[1])
>>> list(res)
[]

>>> res = loop_in_pairs(iterable=range(0, 10))
>>> list(res)
[(0, 1), (1, 2), (2, 3), (3, 4), (4, 5), (5, 6), (6, 7), (7, 8), (8, 9)]
```

split_list_by_size

`pyhelpers.ops.split_list_by_size(lst, sub_len)`

Split a list into (evenly sized) sub-lists.

See also [\[OPS-SLBS-1\]](#).

Parameters

- **lst** (*list*) – a list of any
- **sub_len** (*int*) – length of a sub-list

Returns a sequence of sub_len-sized sub-lists from lst

Return type *Generator*[list]

Examples:

```
>>> from pyhelpers.ops import split_list_by_size

>>> lst_ = list(range(0, 10))
>>> lst_
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

>>> lists = split_list_by_size(lst_, sub_len=3)
>>> list(lists)
[[0, 1, 2], [3, 4, 5], [6, 7, 8], [9]]
```

split_list

`pyhelpers.ops.split_list(lst, num_of_sub)`

Split a list into a number of equally-sized sub-lists.

See also [\[OPS-SL-1\]](#).

Parameters

- **lst** (*list*) – a list of any
- **num_of_sub** (*int*) – number of sub-lists

Returns a total of num_of_sub sub-lists from lst

Return type *Generator*[list]

Examples:

```
>>> from pyhelpers.ops import split_list

>>> lst_ = list(range(0, 10))
>>> lst_
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

>>> lists = split_list(lst_, num_of_sub=3)
>>> list(lists)
[[0, 1, 2, 3], [4, 5, 6, 7], [8, 9]]
```

split_iterable

`pyhelpers.ops.split_iterable(iterable, chunk_size)`

Split a list into (evenly sized) chunks.

See also [OPS-SI-1].

Parameters

- **iterable** (*Iterable*) – iterable object
- **chunk_size** (*int*) – length of a chunk

Returns a sequence of equally-sized chunks from iterable

Return type *Generator[Iterable]*

Examples:

```
>>> from pyhelpers.ops import split_iterable
>>> import pandas

>>> iterable_1 = list(range(0, 10))
>>> iterable_1
[0, 1, 2, 3, 4, 5, 6, 7, 8, 9]

>>> iterable_1_ = split_iterable(iterable_1, chunk_size=3)
>>> type(iterable_1_)
generator

>>> for dat in iterable_1_:
...     print(list(dat))
[0, 1, 2]
[3, 4, 5]
[6, 7, 8]
[9]

>>> iterable_2 = pandas.Series(range(0, 20))
>>> iterable_2
0      0
1      1
2      2
3      3
4      4
5      5
```

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```

6      6
7      7
8      8
9      9
10     10
11     11
12     12
13     13
14     14
15     15
16     16
17     17
18     18
19     19
dtype: int64

>>> iterable_2_ = split_iterable(iterable_2, chunk_size=5)

>>> for dat in iterable_2_:
...     print(list(dat))
[0, 1, 2, 3, 4]
[5, 6, 7, 8, 9]
[10, 11, 12, 13, 14]
[15, 16, 17, 18, 19]

```

update_dict

`pyhelpers.ops.update_dict(dictionary, updates, inplace=False)`

Update a (nested) dictionary or similar mapping.

See also [\[OPS-UD-1\]](#).

Parameters

- **dictionary** (*dict*) – a (nested) dictionary that needs to be updated
- **updates** (*dict*) – a dictionary with new data
- **inplace** (*bool*) – whether to replace the original dictionary with the updated one, defaults to `False`

Returns an updated dictionary

Return type `dict`

Examples:

```

>>> from pyhelpers.ops import update_dict

>>> source_dict = {'key_1': 1}
>>> update_data = {'key_2': 2}
>>> upd_dict = update_dict(source_dict, updates=update_data)
>>> upd_dict
{'key_1': 1, 'key_2': 2}
>>> source_dict

```

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```

{'key_1': 1}
>>> update_dict(source_dict, updates=update_data, inplace=True)
>>> source_dict
{'key_1': 1, 'key_2': 2}

>>> source_dict = {'key': 'val_old'}
>>> update_data = {'key': 'val_new'}
>>> upd_dict = update_dict(source_dict, updates=update_data)
>>> upd_dict
{'key': 'val_new'}

>>> source_dict = {'key': {'k1': 'v1_old', 'k2': 'v2'}}
>>> update_data = {'key': {'k1': 'v1_new'}}
>>> upd_dict = update_dict(source_dict, updates=update_data)
>>> upd_dict
{'key': {'k1': 'v1_new', 'k2': 'v2'}}

>>> source_dict = {'key': {'k1': {}, 'k2': 'v2'}}
>>> update_data = {'key': {'k1': 'v1'}}
>>> upd_dict = update_dict(source_dict, updates=update_data)
>>> upd_dict
{'key': {'k1': 'v1', 'k2': 'v2'}}

>>> source_dict = {'key': {'k1': 'v1', 'k2': 'v2'}}
>>> update_data = {'key': {'k1': {}}}
>>> upd_dict = update_dict(source_dict, updates=update_data)
>>> upd_dict
{'key': {'k1': 'v1', 'k2': 'v2'}}

```

update_dict_keys

`pyhelpers.ops.update_dict_keys(dictionary, replacements=None)`

Update keys in a (nested) dictionary.

See also [OPS-UDK-1] and [OPS-UDK-2].

Parameters

- **dictionary** (*dict*) – a (nested) dictionary in which certain keys are to be updated
- **replacements** (*dict* or *None*) – a dictionary in the form of `{<current_key>: <new_key>}`, describing which keys are to be updated, defaults to *None*

Returns an updated dictionary

Return type *dict*

Examples:

```

>>> from pyhelpers.ops import update_dict_keys

>>> source_dict = {'a': 1, 'b': 2, 'c': 3}

```

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```

>>> upd_dict = update_dict_keys(source_dict, replacements=None)
>>> upd_dict # remain unchanged
{'a': 1, 'b': 2, 'c': 3}

>>> repl_keys = {'a': 'd', 'c': 'e'}
>>> upd_dict = update_dict_keys(source_dict, replacements=repl_keys)
>>> upd_dict
{'d': 1, 'b': 2, 'e': 3}

>>> source_dict = {'a': 1, 'b': 2, 'c': {'d': 3, 'e': {'f': 4, 'g': 5}}}

>>> repl_keys = {'d': 3, 'f': 4}
>>> upd_dict = update_dict_keys(source_dict, replacements=repl_keys)
>>> upd_dict
{'a': 1, 'b': 2, 'c': {3: 3, 'e': {4: 4, 'g': 5}}}

```

get_dict_values

`pyhelpers.ops.get_dict_values(key, dictionary)`

Get all values in a (nested) dictionary for a given key.

See also [OPS-GDV-1] and [OPS-GDV-2].

Parameters

- **key** (*any*) – any that can be the key of a dictionary
- **dictionary** (*dict*) – a (nested) dictionary

Returns all values of the key within the given `target_dict`

Return type `Generator[Iterable]`

Examples:

```

>>> from pyhelpers.ops import get_dict_values

>>> key_ = 'key'
>>> target_dict_ = {'key': 'val'}
>>> val = get_dict_values(key_, target_dict_)
>>> list(val)
[['val']]

>>> key_ = 'k1'
>>> target_dict_ = {'key': {'k1': 'v1', 'k2': 'v2'}}
>>> val = get_dict_values(key_, target_dict_)
>>> list(val)
[['v1']]

>>> key_ = 'k1'
>>> target_dict_ = {'key': {'k1': ['v1', 'v1_1']}}
>>> val = get_dict_values(key_, target_dict_)
>>> list(val)
[['v1', 'v1_1']]

```

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```
>>> key_ = 'k2'
>>> target_dict_ = {'key': {'k1': 'v1', 'k2': ['v2', 'v2_1']}}
>>> val = get_dict_values(key_, target_dict_)
>>> list(val)
[['v2', 'v2_1']]
```

remove_dict_keys

`pyhelpers.ops.remove_dict_keys(dictionary, *keys)`

Remove multiple keys from a dictionary.

Parameters

- **dictionary** (*dict*) – a dictionary
- **keys** (*any*) – (a sequence of) any that can be the key of a dictionary

Examples:

```
>>> from pyhelpers.ops import remove_dict_keys
>>> target_dict_ = {'k1': 'v1', 'k2': 'v2', 'k3': 'v3', 'k4': 'v4', 'k5': 'v5'}
>>> remove_dict_keys(target_dict_, 'k1', 'k3', 'k4')
>>> target_dict_
{'k2': 'v2', 'k5': 'v5'}
```

compare_dicts

`pyhelpers.ops.compare_dicts(dict1, dict2)`

Compare the difference between two dictionaries.

See also [OPS-CD-1].

Parameters

- **dict1** (*dict*) – a dictionary
- **dict2** (*dict*) – another dictionary

Returns in comparison to dict1, the main difference on dict2, including: modified items, keys that are the same, keys where values remain unchanged, new keys and keys that are removed

Return type *Tuple*[dict, list]

Examples:

```
>>> from pyhelpers.ops import compare_dicts
>>> d1 = {'a': 1, 'b': 2, 'c': 3}
```

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```
>>> d2 = {'b': 2, 'c': 4, 'd': [5, 6]}

>>> items_modified, k_shared, k_unchanged, k_new, k_removed = compare_dicts(d1, d2)
>>> items_modified
{'c': [3, 4]}
>>> k_shared
['b', 'c']
>>> k_unchanged
['b']
>>> k_new
['d']
>>> k_removed
['a']
```

merge_dicts

`pyhelpers.ops.merge_dicts(*dicts)`

Merge multiple dictionaries.

Parameters `dicts` (*dict*) – (one or) multiple dictionaries

Returns a single dictionary containing all elements of the input

Return type dict

Examples:

```
>>> from pyhelpers.ops import merge_dicts

>>> dict_a = {'a': 1}
>>> dict_b = {'b': 2}
>>> dict_c = {'c': 3}

>>> merged_dict = merge_dicts(dict_a, dict_b, dict_c)
>>> merged_dict
{'a': 1, 'b': 2, 'c': 3}

>>> dict_c_ = {'c': 4}
>>> merged_dict = merge_dicts(merged_dict, dict_c_)
>>> merged_dict
{'a': 1, 'b': 2, 'c': [3, 4]}

>>> dict_1 = merged_dict
>>> dict_2 = {'b': 2, 'c': 4, 'd': [5, 6]}
>>> merged_dict = merge_dicts(dict_1, dict_2)
{'a': 1, 'b': 2, 'c': [[3, 4], 4], 'd': [5, 6]}
```

Tabular data

<code>detect_nan_for_str_column(data_frame[, ...])</code>	Detect if a str type column contains NaN when reading csv files.
<code>create_rotation_matrix(theta)</code>	Create a rotation matrix (counterclockwise).
<code>dict_to_dataframe(input_dict[, k, v])</code>	Convert a dictionary to a data frame.
<code>parse_csr_matrix(path_to_csr[, verbose])</code>	Load in a compressed sparse row (CSR) or compressed row storage (CRS).
<code>swap_cols(array, c1, c2[, as_list])</code>	Swap positions of two columns in an array.
<code>swap_rows(array, r1, r2[, as_list])</code>	Swap positions of two rows in an array.
<code>np_shift(array, step[, fill_value])</code>	Shift an array by desired number of rows.

detect_nan_for_str_column

`pyhelpers.ops.detect_nan_for_str_column(data_frame, column_names=None)`

Detect if a str type column contains NaN when reading csv files.

Parameters

- **data_frame** (*pandas.DataFrame*) – a data frame to be examined
- **column_names** (*None or collections.abc.Iterable*) – a sequence of column names, if *None* (default), all columns

Returns position index of the column that contains NaN

Return type *Generator[Iterable]*

Examples:

```
>>> from pyhelpers.ops import detect_nan_for_str_column
>>> from pyhelpers._cache import example_dataframe

>>> dat = example_dataframe()
>>> dat
      Easting  Northing
City
London      530034    180381
Birmingham  406689    286822
Manchester   383819    398052
Leeds        582044    152953

>>> dat.loc['Leeds', 'Northing'] = None
>>> dat
      Easting  Northing
City
London      530034    180381.0
Birmingham  406689    286822.0
Manchester   383819    398052.0
Leeds        582044         NaN

>>> nan_col_pos = detect_nan_for_str_column(data_frame=dat, column_names=None)
>>> list(nan_col_pos)
[1]
```

create_rotation_matrix

`pyhelpers.ops.create_rotation_matrix(theta)`

Create a rotation matrix (counterclockwise).

Parameters `theta` (*int* or *float*) – rotation angle (in radian)

Returns a rotation matrix of shape (2, 2)

Return type `numpy.ndarray`

Examples:

```
>>> from pyhelpers.ops import create_rotation_matrix

>>> rot_mat = create_rotation_matrix(theta=30)
>>> rot_mat
array([[ -0.98803162,  0.15425145],
       [ 0.15425145, -0.98803162]])
```

dict_to_dataframe

`pyhelpers.ops.dict_to_dataframe(input_dict, k='key', v='value')`

Convert a dictionary to a data frame.

Parameters

- `input_dict` (*dict*) – a dictionary to be converted to a data frame
- `k` (*str*) – column name for keys
- `v` (*str*) – column name for values

Returns a data frame converted from the `input_dict`

Return type `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.ops import dict_to_dataframe

>>> test_dict = {'a': 1, 'b': 2}

>>> dat = dict_to_dataframe(input_dict=test_dict)
>>> dat
   key  value
0    a      1
1    b      2
```

parse_csr_matrix

`pyhelpers.ops.parse_csr_matrix(path_to_csr, verbose=False, **kwargs)`

Load in a compressed sparse row (CSR) or compressed row storage (CRS).

Parameters

- **path_to_csr** (*str*) – path where a CSR file (e.g. with a file extension “.npz”) is saved
- **verbose** (*bool or int*) – whether to print relevant information in console as the function runs, defaults to False
- **kwargs** – [optional] parameters of `numpy.load`

Returns a compressed sparse row

Return type `scipy.sparse.csr.csr_matrix`

Examples:

```
>>> from pyhelpers.ops import parse_csr_matrix
>>> from pyhelpers.dir import cd
>>> import numpy
>>> import scipy.sparse

>>> data_ = numpy.array([1, 2, 3, 4, 5, 6])
>>> indices_ = numpy.array([0, 2, 2, 0, 1, 2])
>>> indptr_ = numpy.array([0, 2, 3, 6])

>>> csr_m = scipy.sparse.csr_matrix((data_, indices_, indptr_), shape=(3, 3))
>>> csr_m
<3x3 sparse matrix of type '<class 'numpy.int32'>'
  with 6 stored elements in Compressed Sparse Row format>

>>> path_to_csr_npz = cd("tests\data", "csr_mat.npz")
>>> numpy.savez_compressed(path_to_csr_npz, indptr=csr_m.indptr,
...                        indices=csr_m.indices, data=csr_m.data,
...                        shape=csr_m.shape)

>>> parsed_csr_mat = parse_csr_matrix(path_to_csr_npz, verbose=True)
Loading "\tests\data\csr_mat.npz" ... Done.

>>> # .nnz gets the count of explicitly-stored values (non-zeros)
>>> (parsed_csr_mat != csr_m).count_nonzero() == 0
True

>>> (parsed_csr_mat != csr_m).nnz == 0
True
```

swap_cols

`pyhelpers.ops.swap_cols(array, c1, c2, as_list=False)`

Swap positions of two columns in an array.

Parameters

- **array** (*numpy.ndarray*) – an array
- **c1** (*int*) – index of a column
- **c2** (*int*) – index of another column
- **as_list** (*bool*) – whether to return a list

Returns a new array/list in which the positions of the c1-th and c2-th columns are swapped

Return type `numpy.ndarray` or `list`

Examples:

```
>>> from pyhelpers.ops import swap_cols
>>> from pyhelpers._cache import example_dataframe

>>> example_arr = example_dataframe().to_numpy(dtype=int)
>>> example_arr
array([[530034, 180381],
       [406689, 286822],
       [383819, 398052],
       [582044, 152953]])

>>> # Swap the 0th and 1st columns
>>> new_arr = swap_cols(example_arr, c1=0, c2=1)
>>> new_arr
array([[180381, 530034],
       [286822, 406689],
       [398052, 383819],
       [152953, 582044]])

>>> new_list = swap_cols(example_arr, c1=0, c2=1, as_list=True)
>>> new_list
[[180381, 530034], [286822, 406689], [398052, 383819], [152953, 582044]]
```

swap_rows

`pyhelpers.ops.swap_rows(array, r1, r2, as_list=False)`

Swap positions of two rows in an array.

Parameters

- **array** (*numpy.ndarray*) – an array
- **r1** (*int*) – index of a row
- **r2** (*int*) – index of another row
- **as_list** (*bool*) – whether to return a list

Returns a new array/list in which the positions of the r1-th and r2-th rows are swapped

Return type numpy.ndarray or list

Examples:

```
>>> from pyhelpers.ops import swap_rows
>>> from pyhelpers._cache import example_dataframe

>>> example_arr = example_dataframe().to_numpy(dtype=int)
>>> example_arr
array([[530034, 180381],
       [406689, 286822],
       [383819, 398052],
       [582044, 152953]])

>>> # Swap the 0th and 1st rows
>>> new_arr = swap_rows(example_arr, r1=0, r2=1)
>>> new_arr
array([[406689, 286822],
       [530034, 180381],
       [383819, 398052],
       [582044, 152953]])

>>> new_list = swap_rows(example_arr, r1=0, r2=1, as_list=True)
>>> new_list
[[406689, 286822], [530034, 180381], [383819, 398052], [582044, 152953]]
```

np_shift

pyhelpers.ops.**np_shift**(array, step, fill_value=nan)

Shift an array by desired number of rows.

See also [OPS-NS-1]

Parameters

- **array** (numpy.ndarray) – an array of numbers
- **step** (int) – number of rows to shift
- **fill_value** (float or int) – values to fill missing rows due to the shift, defaults to NaN

Returns shifted array

Return type numpy.ndarray

Examples:

```
>>> from pyhelpers.ops import np_shift
>>> from pyhelpers._cache import example_dataframe

>>> arr = example_dataframe().to_numpy()
>>> arr
array([[530034, 180381],
```

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```

[406689, 286822],
[383819, 398052],
[582044, 152953]], dtype=int64)

>>> np_shift(arr, step=-1)
array([[406689., 286822.],
       [383819., 398052.],
       [582044., 152953.],
       [    nan,     nan]])

>>> np_shift(arr, step=1, fill_value=0)
array([[    0,     0],
       [530034, 180381],
       [406689, 286822],
       [383819, 398052]], dtype=int64)

```

3.3.3 Basic computation

<code>get_extreme_outlier_bounds(num_dat[, k])</code>	Get upper and lower bounds for extreme outliers.
<code>interquartile_range(num_dat)</code>	Calculate interquartile range.
<code>find_closest_date(date, lookup_dates[, ...])</code>	Find the closest date of a given one from a list of dates.

get_extreme_outlier_bounds

`pyhelpers.ops.get_extreme_outlier_bounds(num_dat, k=1.5)`

Get upper and lower bounds for extreme outliers.

Parameters

- **num_dat** (*array-like*) – an array of numbers
- **k** (*float*, *int*) – a scale coefficient associated with interquartile range, defaults to 1.5

Returns lower and upper bound

Return type tuple

Examples:

```

>>> from pyhelpers.ops import get_extreme_outlier_bounds
>>> import pandas

>>> data = pandas.DataFrame(range(100), columns=['col'])
>>> data
   col
0    0
1    1
2    2

```

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```

3      3
4      4
..     ...
95     95
96     96
97     97
98     98
99     99

[100 rows x 1 columns]

>>> data.describe()
           col
count  100.000000
mean    49.500000
std     29.011492
min       0.000000
25%     24.750000
50%     49.500000
75%     74.250000
max     99.000000

>>> lo_bound, up_bound = get_extreme_outlier_bounds(data, k=1.5)
>>> lo_bound, up_bound
(0.0, 148.5)

```

interquartile_range

`pyhelpers.ops.interquartile_range(num_dat)`

Calculate interquartile range.

This function may be an alternative to [scipy.stats.iqr](#).

Parameters `num_dat` (*numpy.ndarray* or *list* or *tuple*) – an array of numbers

Returns interquartile range of `num_dat`

Return type float

Examples:

```

>>> from pyhelpers.ops import interquartile_range

>>> data = list(range(100))

>>> iqr_result = interquartile_range(data)
>>> iqr_result
49.5

```

find_closest_date

```
pyhelpers.ops.find_closest_date(date, lookup_dates, as_datetime=False, fmt='%Y-%m-%d %H:%M:%S.%f')
```

Find the closest date of a given one from a list of dates.

Parameters

- **date** (*str* or *datetime.datetime*) – a date
- **lookup_dates** (*Iterable*) – an array of dates
- **as_datetime** (*bool*) – whether to return a *datetime.datetime*-formatted date, defaults to *False*
- **fmt** (*str*) – datetime format, defaults to `'%Y-%m-%d %H:%M:%S.%f'`

Returns the date that is closest to the given date

Return type *str* or *datetime.datetime*

Examples:

```
>>> from pyhelpers.ops import find_closest_date
>>> import pandas

>>> example_dates = pandas.date_range('2019-01-02', '2019-12-31')
>>> example_dates
DatetimeIndex(['2019-01-02', '2019-01-03', '2019-01-04', '2019-01-05',
              '2019-01-06', '2019-01-07', '2019-01-08', '2019-01-09',
              '2019-01-10', '2019-01-11',
              ...,
              '2019-12-22', '2019-12-23', '2019-12-24', '2019-12-25',
              '2019-12-26', '2019-12-27', '2019-12-28', '2019-12-29',
              '2019-12-30', '2019-12-31'],
              dtype='datetime64[ns]', length=364, freq='D')

>>> example_date = '2019-01-01'
>>> closest_example_date = find_closest_date(example_date, example_dates)
>>> closest_example_date
'2019-01-02 00:00:00.000000'

>>> example_date = pandas.to_datetime('2019-01-01')
>>> closest_example_date = find_closest_date(example_date, example_dates, as_datetime=True)
>>> closest_example_date
Timestamp('2019-01-02 00:00:00', freq='D')
```

3.3.4 Graph plotting

<code>cmap_discretisation(cmap, n_colours)</code>	Create a discrete colour ramp.
<code>colour_bar_index(cmap, n_colours[, labels])</code>	Create a colour bar.

`cmap_discretisation`

`pyhelpers.ops.cmap_discretisation(cmap, n_colours)`

Create a discrete colour ramp.

See also [OPS-CD-1].

Parameters

- `cmap` (`matplotlib.colors.ListedColormap`) – a colormap instance, e.g. built-in `colormaps` that is accessible via `matplotlib.cm.get_cmap`
- `n_colours` (`int`) – number of colours

Returns a discrete colormap from (the continuous) `cmap`

Return type `matplotlib.colors.LinearSegmentedColormap`

Examples:

```
>>> from pyhelpers.ops import cmap_discretisation
>>> import matplotlib.cm
>>> import matplotlib.pyplot as plt
>>> import numpy

>>> cm_accent = cmap_discretisation(matplotlib.cm.get_cmap('Accent'), n_colours=5)
>>> cm_accent.name
'Accent_5'

>>> fig, ax = plt.subplots(figsize=(10, 2))

>>> ax.imshow(numpy.resize(range(100), (5, 100)), cmap=cm_accent, interpolation='nearest')

>>> plt.axis('off')
>>> plt.tight_layout()
>>> plt.show()
```

The example is illustrated in Fig. 4:



Fig. 4: An example of discrete colour ramp, created by the function `cmap_discretisation()`.

```
>>> plt.close()
```

colour_bar_index

`pyhelpers.ops.colour_bar_index(cmap, n_colours, labels=None, **kwargs)`

Create a colour bar.

To stop making off-by-one errors. Takes a standard colour ramp, and discretizes it, then draws a colour bar with correctly aligned labels.

See also [\[OPS-CBI-1\]](#).

Parameters

- **cmap** (*matplotlib.colors.ListedColormap*) – a colormap instance, e.g. built-in [colormaps](#) that is accessible via `matplotlib.cm.get_cmap`
- **n_colours** (*int*) – number of colours
- **labels** (*list or None*) – a list of labels for the colour bar, defaults to `None`
- **kwargs** – [optional] parameters of `matplotlib.pyplot.colorbar`

Returns a colour bar object

Return type `matplotlib.colorbar.Colorbar`

Examples:

```
>>> from pyhelpers.ops import colour_bar_index
>>> import matplotlib.pyplot as plt
>>> import matplotlib.cm

>>> plt.figure(figsize=(2, 6))

>>> cbar = colour_bar_index(cmap=matplotlib.cm.get_cmap('Accent'), n_colours=5)

>>> plt.xticks(fontsize=12)
>>> plt.yticks(fontsize=12)
>>> cbar.ax.tick_params(labelsize=14)

>>> # plt.axis('off')
>>> plt.tight_layout()
>>> plt.show()
```

The above example is illustrated in [Fig. 5](#):

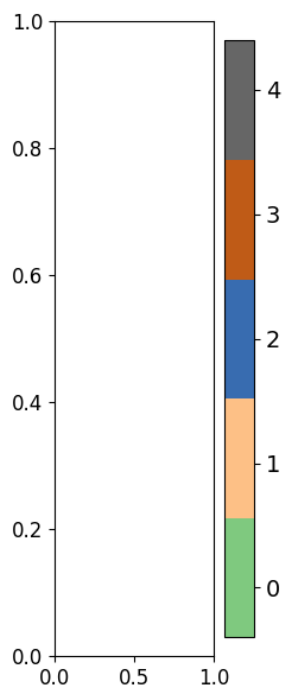


Fig. 5: An example of colour bar with numerical index, created by the function `colour_bar_index()`.

```
>>> plt.figure(figsize=(2, 6))

>>> labels_ = list('abcde')
>>> cbar = colour_bar_index(matplotlib.cm.get_cmap('Accent'), n_colours=5, labels=labels_)

>>> plt.xticks(fontsize=12)
>>> plt.yticks(fontsize=12)
>>> cbar.ax.tick_params(labelsize=14)

>>> # plt.axis('off')
>>> plt.tight_layout()
>>> plt.show()
```

This second example is illustrated in Fig. 6:

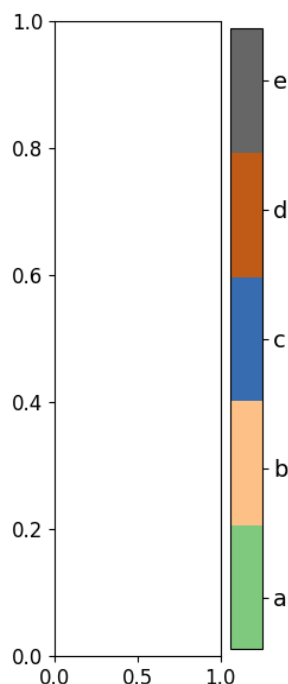


Fig. 6: An example of colour bar with textual index, created by the function `colour_bar_index()`.

```
>>> plt.close(fig='all')
```

3.3.5 Web data extraction

<code>is_network_connected()</code>	Check whether the current machine can connect to the Internet.
<code>is_url(url[, partially])</code>	Check whether url is a valid URL.
<code>is_url_connectable(url)</code>	Check whether the current machine can connect to a given URL.
<code>is_downloadable(url[, request_field])</code>	Check whether a URL leads to a web page where there is downloadable contents.
<code>init_requests_session(url[, max_retries, ...])</code>	Instantiate a <code>requests</code> session.
<code>load_user_agent_strings([shuffled, ...])</code>	Load user-agent strings of popular browsers.
<code>get_user_agent_string([fancy])</code>	Get a random user-agent string of a certain browser.
<code>fake_requests_headers([randomized])</code>	Make a fake HTTP headers for <code>requests.get</code> .
<code>download_file_from_url(url, path_to_file, ...)</code>	Download an object available at a valid URL.

is_network_connected

`pyhelpers.ops.is_network_connected()`

Check whether the current machine can connect to the Internet.

Returns whether the Internet connection is currently working

Return type bool

Examples:

```
>>> from pyhelpers.ops import is_network_connected

>>> is_network_connected() # assuming the machine is currently connected to the Internet
True
```

is_url

`pyhelpers.ops.is_url(url, partially=False)`

Check whether url is a valid URL.

See also [OPS-IU-1]

Parameters

- **url** (*str*) – a string-type variable
- **partially** (*bool*) – whether to consider the input as partially valid, defaults to False

Returns whether url is a valid URL

Return type bool

Examples:

```
>>> from pyhelpers.ops import is_url

>>> is_url(url='https://github.com/mikeqfu/pyhelpers')
True

>>> is_url(url='github.com/mikeqfu/pyhelpers')
False

>>> is_url(url='github.com/mikeqfu/pyhelpers', partially=True)
True

>>> is_url(url='github.com')
False

>>> is_url(url='github.com', partially=True)
True

>>> is_url(url='github', partially=True)
False
```


is_url_connectable

`pyhelpers.ops.is_url_connectable(url)`

Check whether the current machine can connect to a given URL.

Parameters `url` (*str*) – a (valid) URL

Returns whether the machine can currently connect to the given URL

Return type `bool`

Examples:

```
>>> from pyhelpers.ops import is_url_connectable

>>> url_0 = 'https://www.python.org/'
>>> is_url_connectable(url_0)
True

>>> url_1 = 'https://www.python.org1/'
>>> is_url_connectable(url_1)
False
```

is_downloadable

`pyhelpers.ops.is_downloadable(url, request_field='content-type', **kwargs)`

Check whether a URL leads to a web page where there is downloadable contents.

Parameters

- `url` (*str*) – a valid URL
- `request_field` (*str*) – name of the field/header indicating the original media type of the resource, defaults to 'content-type'
- `kwargs` – [optional] parameters of `requests.head`

Returns whether the url leads to downloadable contents

Return type `bool`

Examples:

```
>>> from pyhelpers.ops import is_downloadable

>>> logo_url = 'https://www.python.org/static/community_logos/python-logo-master-v3-TM.png'
>>> is_downloadable(logo_url)
True

>>> google_url = 'https://www.google.co.uk/'
>>> is_downloadable(google_url)
False
```

init_requests_session

```
pyhelpers.ops.init_requests_session(url, max_retries=5, backoff_factor=0.1, retry_status='default',
                                   **kwargs)
```

Instantiate a `requests` session.

Parameters

- `url` (*str*) – a valid URL
- `max_retries` (*int*) – maximum number of retries, defaults to 5
- `backoff_factor` (*float*) – backoff_factor of `urllib3.util.retry.Retry`, defaults to 0.1
- `retry_status` – a list of HTTP status codes that force to retry downloading, inherited from `status_forcelist` of `urllib3.util.retry.Retry`; when `retry_status='default'`, the list defaults to [429, 500, 502, 503, 504]
- `kwargs` – [optional] parameters of `urllib3.util.retry.Retry`

Returns a `requests` session

Return type `requests.Session`

Examples:

```
>>> from pyhelpers.ops import init_requests_session

>>> logo_url = 'https://www.python.org/static/community_logos/python-logo-master-v3-TM.png'

>>> s = init_requests_session(logo_url)

>>> type(s)
requests.sessions.Session
```

load_user_agent_strings

```
pyhelpers.ops.load_user_agent_strings(shuffled=False, flattened=False, update=False,
                                     verbose=False)
```

Load user-agent strings of popular browsers.

The current version collects a partially comprehensive list of user-agent strings for `Chrome`, `Firefox`, `Safari`, `Edge`, `Internet Explorer` and `Opera`.

Parameters

- `shuffled` (*bool*) – whether to randomly shuffle the user-agent strings, defaults to `False`
- `flattened` (*bool*) – whether to make a list of all available user-agent strings, defaults to `False`
- `update` (*bool*) – whether to update the backup data of user-agent strings, defaults to `False`

- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Returns a dictionary of user agent strings for popular browsers

Return type dict or list

Examples:

```
>>> from pyhelpers.ops import load_user_agent_strings

>>> uas = load_user_agent_strings()

>>> list(uas.keys())
['Chrome', 'Firefox', 'Safari', 'Edge', 'Internet Explorer', 'Opera']
>>> type(uas['Chrome'])
list
>>> uas['Chrome'][0]
'Mozilla/5.0 (Windows NT 10.0; Win64; x64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/...'

>>> uas_list = load_user_agent_strings(shuffled=True, flattened=True)
>>> type(uas_list)
list
>>> uas_list[0] # a random one
'Mozilla/5.0 (Windows NT 6.0) AppleWebKit/535.1 (KHTML, like Gecko) Chrome/14.0.792.0 Saf...'
```

Note: The order of the elements in `uas_list` may be different every time we run the example as `shuffled=True`.

`get_user_agent_string`

`pyhelpers.ops.get_user_agent_string(fancy=None, **kwargs)`

Get a random user-agent string of a certain browser.

Parameters

- **fancy** – name of a preferred browser, defaults to `None`; options include 'Chrome', 'Firefox', 'Safari', 'Edge', 'Internet Explorer' and 'Opera'; if `fancy=None`, the function returns a user-agent string of a randomly-selected browser among all the available options
- **kwargs** – [optional] parameters of the function `pyhelpers.ops.load_user_agent_strings()`

Type fancy: `None` or `str`

Returns a user-agent string of a certain browser

Return type `str`

Examples:

```
>>> from pyhelpers.ops import get_user_agent_string

>>> # Get a random user-agent string
>>> uas_0 = get_user_agent_string()
>>> uas_0
'Opera/7.01 (Windows 98; U) [en]'

>>> # Get a random Chrome user-agent string
>>> uas_1 = get_user_agent_string(fancy='Chrome')
>>> uas_1
'Mozilla/5.0 (Windows NT 6.0; WOW64) AppleWebKit/535.11 (KHTML, like Gecko) Chrome/17.0.9...
```

Note: In the above examples, the returned user-agent string is random and may be different every time of running the function.

fake_requests_headers

`pyhelpers.ops.fake_requests_headers(randomized=True, **kwargs)`

Make a fake HTTP headers for `requests.get`.

Parameters

- **randomized** (*bool*) – whether to use a user-agent string randomly selected from among all available data of several popular browsers, defaults to `True`; if `randomized=False`, the function uses a random Chrome user-agent string
- **kwargs** – [optional] parameters of the function
`pyhelpers.ops.get_user_agent_string()`

Returns fake HTTP headers

Return type dict

Examples:

```
>>> from pyhelpers.ops import fake_requests_headers

>>> fake_headers_1 = fake_requests_headers()
>>> fake_headers_1
{'user-agent': 'Mozilla/5.0 (Windows; U; Windows NT 5.1; it-IT) AppleWebKit/525.19 (KHTML...

>>> fake_headers_2 = fake_requests_headers(randomized=False)
>>> fake_headers_2 # using a random Chrome user-agent string
{'user-agent': 'Mozilla/5.0 (Windows; U; Windows NT 6.1; en-US) AppleWebKit/532.1 (KHTML,...
```

Note:

- `fake_headers_1` may also be different every time we run the example. This is because the returned result is randomly chosen from a limited set of candidate user-agent strings, even though `randomized` is (by default) set to be `False`.

- By setting `randomized=True`, the function returns a random result from among all available user-agent strings of several popular browsers.

download_file_from_url

```
pyhelpers.ops.download_file_from_url(url, path_to_file, if_exists='replace', max_retries=5,
                                     random_header=True, verbose=False,
                                     requests_session_args=None, fake_headers_args=None,
                                     **kwargs)
```

Download an object available at a valid URL.

See also [OPS-DFFU-1] and [OPS-DFFU-2].

Parameters

- `url` (*str*) – valid URL to a web resource
- `path_to_file` (*str* or *os.PathLike[str]*) – a path where the downloaded object is saved as, or a filename
- `if_exists` (*str*) – given that the specified file already exists, options include 'replace' (default, continuing to download the requested file and replace the existing one at the specified path) and 'pass' (cancelling the download)
- `max_retries` (*int*) – maximum number of retries, defaults to 5
- `random_header` (*bool*) – whether to go for a random agent, defaults to True
- `verbose` (*bool* or *int*) – whether to print relevant information in console, defaults to False
- `requests_session_args` (*dict* or *None*) – [optional] parameters of the function `pyhelpers.ops.init_requests_session()`, defaults to None
- `fake_headers_args` (*dict* or *None*) – [optional] parameters of the function `pyhelpers.ops.fake_requests_headers()`, defaults to None
- `kwargs` – [optional] parameters of `requests.Session.get()`

Examples:

```
>>> from pyhelpers.ops import download_file_from_url
>>> from pyhelpers.dir import cd
>>> from PIL import Image
>>> import os

>>> logo_url = 'https://www.python.org/static/community_logos/python-logo-master-v3-TM.png'
>>> path_to_img = cd("tests", "images", "ops-download_file_from_url-demo.png")

>>> # Check if "python-logo.png" exists at the specified path
>>> os.path.exists(path_to_img)
False

>>> # Download the .png file
```

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```
>>> download_file_from_url(logo_url, path_to_img)

>>> # If download is successful, check again:
>>> os.path.exists(path_to_img)
True

>>> img = Image.open(path_to_img)
>>> img.show() # as illustrated below
```



Fig. 7: The Python Logo.

Note:

- When `verbose=True`, the function requires `tqdm`.
-

3.4 store

Saving, loading and other relevant operations of file-like objects.

3.4.1 Data saving

<code>save_pickle(pickle_data, path_to_pickle[, ...])</code>	Save data to a Pickle file.
<code>save_spreadsheet(spreadsheet_data, ...[, ...])</code>	Save data to a CSV or an Microsoft Excel file.
<code>save_spreadsheets(spreadsheets_data, ...[, ...])</code>	Save data to a multi-sheet Microsoft Excel file.
<code>save_json(json_data, path_to_json[, method, ...])</code>	Save data to a JSON file.
<code>save_joblib(joblib_data, path_to_joblib[, ...])</code>	Save data to a Joblib file.
<code>save_feather(feather_data, path_to_feather)</code>	Save a dataframe to a Feather file.
<code>save_svg_as_emf(path_to_svg, path_to_emf[, ...])</code>	Save a SVG file (.svg) as a EMF file (.emf).
<code>save_fig(path_to_fig_file[, dpi, verbose, ...])</code>	Save a figure object to a file of a supported file format.
<code>save_web_page_as_pdf(web_page, path_to_pdf)</code>	Save a web page as a PDF file by wkhtmltopdf .
<code>save_data(data, path_to_file[, warning])</code>	Save data to a file of a specific format.

save_pickle

`pyhelpers.store.save_pickle(pickle_data, path_to_pickle, verbose=False, **kwargs)`

Save data to a [Pickle](#) file.

Parameters

- **pickle_data** (*any*) – data that could be dumped by the built-in module [pickle.dump](#)
- **path_to_pickle** (*str* or *os.PathLike[str]*) – path where a pickle file is saved
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of [pickle.dump](#)

Examples:

```
>>> from pyhelpers.store import save_pickle
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe

>>> pickle_dat = 1

>>> pickle_pathname = cd("tests\data", "dat.pickle")
>>> save_pickle(pickle_dat, pickle_pathname, verbose=True)
Saving "dat.pickle" to "tests\data\" ... Done.

>>> # Get an example dataframe
>>> pickle_dat = example_dataframe()
>>> pickle_dat
```

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City	Longitude	Latitude
London	-0.127647	51.507322
Birmingham	-1.902691	52.479699
Manchester	-2.245115	53.479489
Leeds	-1.543794	53.797418

```
>>> save_pickle(pickle_dat, pickle_pathname, verbose=True)
Updating "dat.pickle" at "tests\data\" ... Done.
```

See also:

- Examples for the function `pyhelpers.store.load_pickle()`.

save_spreadsheet

```
pyhelpers.store.save_spreadsheet(spreadsheet_data, path_to_spreadsheet, index=False,
                                engine=None, delimiter=',', verbose=False, **kwargs)
```

Save data to a [CSV](#) or an [Microsoft Excel](#) file.

The file extension can be `".txt"`, `".csv"`, `".xlsx"` or `".xls"`; engines can include: [xlsxwriter](#) (for `.xlsx`) and [openpyxl](#) (for `.xlsx/.xlsm`).

Parameters

- **spreadsheet_data** (`pandas.DataFrame`) – data that could be saved as a spreadsheet (e.g. with a file extension `".xlsx"` or `".csv"`)
- **path_to_spreadsheet** (`str` or `os.PathLike[str]` or `None`) – path where a spreadsheet is saved
- **index** (`bool`) – whether to include the index as a column, defaults to `False`
- **engine** (`str` or `None`) – options include `'openpyxl'` for latest Excel file formats, `'xlrd'` for `.xls` `'odf'` for OpenDocument file formats (`.odf`, `.ods`, `.odt`), and `'pyxlsb'` for Binary Excel files; defaults to `None`
- **delimiter** (`str`) – separator for saving a `".xlsx"` (or `".xls"`) file as a `".csv"` file, defaults to `','`
- **verbose** (`bool` or `int`) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of [pandas.DataFrame.to_excel](#) or [pandas.DataFrame.to_csv](#)

Examples:

```
>>> from pyhelpers.store import save_spreadsheet
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe

>>> # Get an example dataframe
```

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```
>>> spreadsheet_dat = example_dataframe()
>>> spreadsheet_dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> spreadsheet_pathname = cd("tests\data", "dat.csv")
>>> save_spreadsheet(spreadsheet_dat, spreadsheet_pathname, index=True, verbose=True)
Saving "dat.csv" to "tests\data\" ... Done.

>>> spreadsheet_pathname = cd("tests\data", "dat.xlsx")
>>> save_spreadsheet(spreadsheet_dat, spreadsheet_pathname, index=True, verbose=True)
Saving "dat.xlsx" to "tests\data\" ... Done.
```

save_spreadsheets

`pyhelpers.store.save_spreadsheets(spreadsheets_data, sheet_names, path_to_spreadsheet, mode='w', index=False, confirmation_required=True, verbose=False, **kwargs)`

Save data to a multi-sheet [Microsoft Excel](#) file.

The file extension can be `“.xlsx”` or `“.xls”`.

Parameters

- **spreadsheets_data** (*list or tuple or iterable*) – a sequence of `pandas.DataFrame`
- **sheet_names** (*list or tuple or iterable*) – all sheet names of an Excel workbook
- **path_to_spreadsheet** (*str or os.PathLike[str]*) – path where a spreadsheet is saved
- **mode** (*str*) – mode to write to an Excel file; 'w' (default) for 'write' and 'a' for 'append'
- **index** (*bool*) – whether to include the index as a column, defaults to False
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to True
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to False
- **kwargs** – [optional] parameters of [pandas.ExcelWriter](#)

Examples:

```
>>> from pyhelpers.store import save_spreadsheets
>>> from pyhelpers.dir import cd
```

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```

>>> from pyhelpers._cache import example_dataframe

>>> dat1 = example_dataframe() # Get an example dataframe
>>> dat1
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham  -1.902691  52.479699
Manchester   -2.245115  53.479489
Leeds        -1.543794  53.797418

>>> dat2 = dat1.T
>>> dat2
City      London  Birmingham  Manchester      Leeds
Longitude -0.127647  -1.902691  -2.245115  -1.543794
Latitude  51.507322  52.479699  53.479489  53.797418

>>> dat = [dat1, dat2]
>>> dat_sheets = ['TestSheet1', 'TestSheet2']
>>> dat_pathname = cd("tests\data", "dat.xlsx")

>>> save_spreadsheets(dat, dat_sheets, dat_pathname, index=True, verbose=True)
Saving "dat.xlsx" to "tests\data\" ...
'TestSheet1' ... Done.
'TestSheet2' ... Done.

>>> save_spreadsheets(dat, dat_sheets, dat_pathname, mode='a', index=True, verbose=True)
Updating "dat.xlsx" at "tests\data\" ...
'TestSheet1' ... This sheet already exists; [pass]|new|replace: new
saved as 'TestSheet11' ... Done.
'TestSheet2' ... This sheet already exists; [pass]|new|replace: new
saved as 'TestSheet21' ... Done.

>>> save_spreadsheets(dat, dat_sheets, dat_pathname, mode='a', index=True,
...                    confirmation_required=False, verbose=True)
Updating "dat.xlsx" at "tests\dataaz" ...
'TestSheet1' ... Failed. Sheet 'TestSheet1' already exists and if_sheet_exists is se ...
'TestSheet2' ... Failed. Sheet 'TestSheet2' already exists and if_sheet_exists is se ...

>>> save_spreadsheets(dat, dat_sheets, dat_pathname, mode='a', index=True,
...                    confirmation_required=False, verbose=True, if_sheet_exists='replace')
Updating "dat.xlsx" at "tests\data\" ...
'TestSheet1' ... Done.
'TestSheet2' ... Done.

```

save_json

pyhelpers.store.**save_json**(json_data, path_to_json, method=None, verbose=False, **kwargs)

Save data to a JSON file.

Parameters

- **json_data** (any json data) – data that could be dumped by as a JSON file
- **path_to_json** (str or os.PathLike[str]) – path where a json file is

saved

- **method** (*str* or *None*) – an open-source module used for JSON serialization, options include *None* (default, for the built-in `json` module), `'ujson'` (for [UltraJSON](#)), `'orjson'` (for [orjson](#)) and `'rapidjson'` (for [python-rapidjson](#))
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to *False*
- **kwargs** – [optional] parameters of `json.dump()` (if `method=None`), `orjson.dumps()` (if `method='orjson'`), `ujson.dump()` (if `method='ujson'`) or `rapidjson.dump()` (if `method='rapidjson'`)

Examples:

```
>>> from pyhelpers.store import save_json
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe
>>> import json

>>> json_pathname = cd("tests\data", "dat.json")

>>> json_dat = {'a': 1, 'b': 2, 'c': 3, 'd': ['a', 'b', 'c']}
>>> save_json(json_dat, json_pathname, indent=4, verbose=True)
Saving "dat.json" to "tests\data\" ... Done.

>>> # Get an example dataframe
>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> # Convert the dataframe to JSON format
>>> json_dat = json.loads(example_df.to_json(orient='index'))
>>> json_dat
{'London': {'Longitude': -0.1276474, 'Latitude': 51.5073219},
 'Birmingham': {'Longitude': -1.9026911, 'Latitude': 52.4796992},
 'Manchester': {'Longitude': -2.2451148, 'Latitude': 53.4794892},
 'Leeds': {'Longitude': -1.5437941, 'Latitude': 53.7974185}}

>>> # Use built-in json module
>>> save_json(json_dat, json_pathname, indent=4, verbose=True)
Updating "dat.json" at "tests\data\" ... Done.

>>> save_json(json_dat, json_pathname, method='orjson', verbose=True)
Updating "dat.json" at "tests\data\" ... Done.

>>> save_json(json_dat, json_pathname, method='ujson', indent=4, verbose=True)
Updating "dat.json" at "tests\data\" ... Done.

>>> save_json(json_dat, json_pathname, method='rapidjson', indent=4, verbose=True)
Updating "dat.json" at "tests\data\" ... Done.
```

See also:

- Examples for the function `pyhelpers.store.load_json()`.

save_joblib

`pyhelpers.store.save_joblib(joblib_data, path_to_joblib, verbose=False, **kwargs)`

Save data to a `Joblib` file.

Parameters

- `joblib_data` (*any*) – data that could be dumped by `joblib.dump`
- `path_to_joblib` (*str* or *os.PathLike[str]*) – path where a pickle file is saved
- `verbose` (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- `kwargs` – [optional] parameters of `joblib.dump`

Examples:

```
>>> from pyhelpers.store import save_joblib
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe
>>> import numpy as np

>>> joblib_pathname = cd("tests\data", "dat.joblib")

>>> # Example 1:
>>> joblib_dat = example_dataframe().to_numpy()
>>> joblib_dat
array([[ -0.1276474,  51.5073219],
       [ -1.9026911,  52.4796992],
       [ -2.2451148,  53.4794892],
       [ -1.5437941,  53.7974185]])

>>> save_joblib(joblib_dat, joblib_pathname, verbose=True)
Saving "dat.joblib" to "tests\data\" ... Done.

>>> # Example 2:
>>> np.random.seed(0)
>>> joblib_dat = np.random.rand(100, 100)
>>> joblib_dat
array([[0.5488135 , 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.5736796 , 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.14193334 ],
```

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```
[0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
 0.81357508]])

>>> save_joblib(joblib_dat, joblib_pathname, verbose=True)
Updating "dat.joblib" at "tests\data\" ... Done.
```

See also:

- Examples for the function `pyhelpers.store.load_joblib()`.

save_feather

`pyhelpers.store.save_feather(feather_data, path_to_feather, index=False, verbose=False, **kwargs)`

Save a dataframe to a [Feather](#) file.

Parameters

- **feather_data** (`pandas.DataFrame`) – a dataframe to be saved as a feather-formatted file
- **path_to_feather** (`str` or `os.PathLike[str]`) – path where a feather file is saved
- **index** (`bool`) – whether to include the index as a column, defaults to `False`
- **verbose** (`bool` or `int`) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of `pandas.DataFrame.to_feather`

Examples:

```
>>> from pyhelpers.store import save_feather
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe

>>> feather_dat = example_dataframe() # Get an example dataframe
>>> feather_dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> feather_pathname = cd("tests\data", "dat.feather")

>>> save_feather(feather_dat, feather_pathname, verbose=True)
Saving "dat.feather" to "tests\data\" ... Done.

>>> save_feather(feather_dat, feather_pathname, index=True, verbose=True)
Updating "dat.feather" at "tests\data\" ... Done.
```

See also:

- Examples for the function `pyhelpers.store.load_feather()`.

`save_svg_as_emf`

```
pyhelpers.store.save_svg_as_emf(path_to_svg, path_to_emf, verbose=False, inkscape_exe=None,
                                **kwargs)
```

Save a [SVG](#) file (.svg) as a [EMF](#) file (.emf).

Parameters

- `path_to_svg` (*str*) – path where a .svg file is saved
- `path_to_emf` (*str*) – path where a .emf file is saved
- `verbose` (*bool or int*) – whether to print relevant information in console, defaults to `False`
- `inkscape_exe` (*str or None*) – absolute path to 'inkscape.exe', defaults to `None`; when `inkscape_exe=None`, use the default installation path, e.g. (on Windows) "`C:\Program Files\Inkscape\bin\inkscape.exe`" or "`C:\Program Files\Inkscape\inkscape.exe`"
- `kwargs` – [optional] parameters of `subprocess.run`

Examples:

```
>>> from pyhelpers.store import save_svg_as_emf
>>> from pyhelpers.dir import cd
>>> from pyhelpers.settings import mpl_preferences
>>> import matplotlib.pyplot as plt

>>> mpl_preferences()

>>> x, y = (1, 1), (2, 2)

>>> plt.figure()
>>> plt.plot([x[0], y[0]], [x[1], y[1]])
>>> plt.show()
```

The above exmaple is illustrated in [Fig. 8](#):

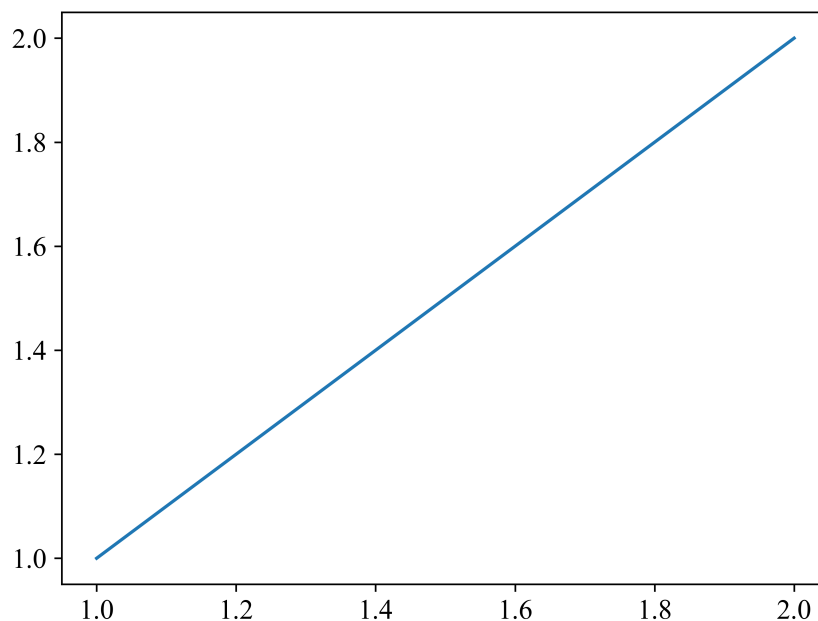


Fig. 8: An example figure created for the function `save_svg_as_emf()`.

```
>>> img_dir = cd("tests\images")
>>> svg_file_pathname = cd(img_dir, "store-save_fig-demo.svg")
>>> plt.savefig(svg_file_pathname) # Save the figure as a .svg file
>>> emf_file_pathname = cd(img_dir, "store-save_fig-demo.emf")
>>> save_svg_as_emf(svg_file_pathname, emf_file_pathname, verbose=True)
Saving the .svg file as "tests\images\store-save_fig-demo.emf" ... Done.
>>> plt.close()
```

save_fig

`pyhelpers.store.save_fig(path_to_fig_file, dpi=None, verbose=False, conv_svg_to_emf=False, **kwargs)`

Save a figure object to a file of a supported file format.

This function relies on `matplotlib.pyplot.savefig` (and `Inkscape`).

Parameters

- `path_to_fig_file` (`str` or `os.PathLike[str]`) – path where a figure file is saved
- `dpi` (`int` or `None`) – the resolution in dots per inch; if `None` (default), use `rcParams['savefig.dpi']`

- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **conv_svg_to_emf** (*bool*) – whether to convert a `.svg` file to a `.emf` file, defaults to `False`
- **kwargs** – [optional] parameters of `matplotlib.pyplot.savefig`

Examples:

```
>>> from pyhelpers.store import save_fig
>>> from pyhelpers.dir import cd
>>> from pyhelpers.settings import mpl_preferences
>>> import matplotlib.pyplot as plt

>>> mpl_preferences()

>>> x, y = (1, 1), (2, 2)

>>> plt.figure()
>>> plt.plot([x[0], y[0]], [x[1], y[1]])
>>> plt.show()
```

The above exmaple is illustrated in Fig. 9:

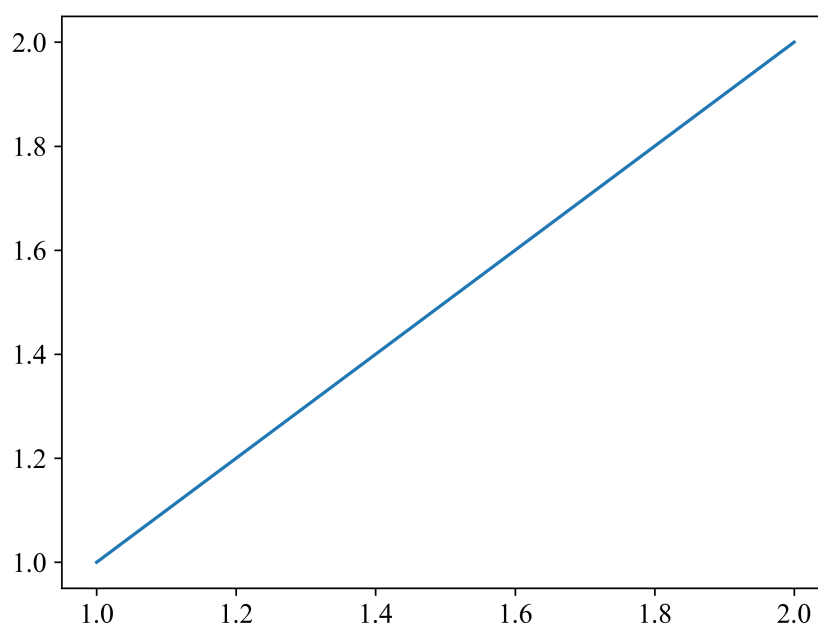


Fig. 9: An example figure created for the function `save_fig()`.

```
>>> img_dir = cd("tests\images")

>>> png_file_pathname = cd(img_dir, "store-save_fig-demo.png")
>>> save_fig(png_file_pathname, dpi=600, verbose=True)
```

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```

Saving "store-save_fig-demo.png" to "tests\images\" ... Done.

>>> svg_file_pathname = cd(img_dir, "store-save_fig-demo.svg")
>>> save_fig(svg_file_pathname, dpi=600, verbose=True, conv_svg_to_emf=True)
Saving "store-save_fig-demo.svg" to "tests\images\" ... Done.
Saving the .svg file as "tests\images\store-save_fig-demo.emf" ... Done.

>>> plt.close()

```

save_web_page_as_pdf

```

pyhelpers.store.save_web_page_as_pdf(web_page, path_to_pdf, page_size='A4', zoom=1.0,
                                     encoding='UTF-8', verbose=False, wkhtmltopdf_exe=None,
                                     **kwargs)

```

Save a web page as a PDF file by `wkhtmltopdf`.

Parameters

- **web_page** (*str*) – URL of a web page or pathname of an HTML file
- **path_to_pdf** (*str*) – path where a .pdf is saved
- **page_size** (*str*) – page size, defaults to 'A4'
- **zoom** (*float*) – a parameter to zoom in/out, defaults to 1.0
- **encoding** (*str*) – encoding format defaults to 'UTF-8'
- **verbose** (*bool*) – whether to print relevant information in console, defaults to False
- **wkhtmltopdf_exe** (*str or None*) – absolute path to 'wkhtmltopdf.exe', defaults to None; when `wkhtmltopdf_exe=None`, use the default installation path, e.g. (on Windows) "C:\Program Files\wkhtmltopdf\bin\wkhtmltopdf.exe"
- **kwargs** – [optional] parameters of `pdfkit.from_url`

Examples:

```

>>> from pyhelpers.store import save_web_page_as_pdf
>>> from pyhelpers.dir import cd
>>> import subprocess

>>> pdf_pathname = cd("tests\documents", "pyhelpers.pdf")

>>> web_page_url = 'https://pyhelpers.readthedocs.io/en/latest/'
>>> save_web_page_as_pdf(web_page_url, pdf_pathname)

>>> # Open the PDF file using the system's default application
>>> subprocess.Popen(pdf_pathname, shell=True)

>>> web_page_file = cd("docs\build\html\index.html")
>>> save_web_page_as_pdf(web_page_file, pdf_pathname, verbose=True)
Updating "pyhelpers.pdf" at "tests\documents\" ...

```

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```

Loading pages (1/6)
Counting pages (2/6)
Resolving links (4/6)
Loading headers and footers (5/6)
Printing pages (6/6)
Done
>>> subprocess.Popen(pdf_pathname, shell=True)

```

save_data

`pyhelpers.store.save_data(data, path_to_file, warning=True, **kwargs)`

Save data to a file of a specific format.

Parameters

- **data** (*any*) – data that could be saved to a file of [Pickle](#), [CSV](#), [Microsoft Excel](#), [JSON](#), [Joblib](#) or [Feather](#) format; a URL of a web page or an [HTML file](#); or an image file of a [Matplotlib](#)-supported format
- **path_to_file** (*str* or *os.PathLike[str]*) – pathname of a file that stores the data
- **warning** (*bool*) – whether to show a warning messages, defaults to `True`
- **kwargs** – [optional] parameters of one of the following functions:
[save_pickle\(\)](#), [save_spreadsheet\(\)](#), [save_json\(\)](#), [save_joblib\(\)](#),
[save_feather\(\)](#), [save_fig\(\)](#) or [save_web_page_as_pdf\(\)](#)

Examples:

```

>>> from pyhelpers.store import save_data
>>> from pyhelpers.dir import cd
>>> from pyhelpers._cache import example_dataframe

>>> data_dir = cd("tests\data")

>>> # Get an example dataframe
>>> dat = example_dataframe()
>>> dat

```

	Longitude	Latitude
City		
London	-0.127647	51.507322
Birmingham	-1.902691	52.479699
Manchester	-2.245115	53.479489
Leeds	-1.543794	53.797418

```

>>> # Save the data to files different formats:

>>> dat_pathname = cd(data_dir, "dat.pickle")
>>> save_data(dat, dat_pathname, verbose=True)
Saving "dat.pickle" to "tests\data\" ... Done.

>>> dat_pathname = cd(data_dir, "dat.csv")
>>> save_data(dat, dat_pathname, index=True, verbose=True)

```

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```

Saving "dat.csv" to "tests\data\" ... Done.

>>> dat_pathname = cd(data_dir, "dat.xlsx")
>>> save_data(dat, dat_pathname, index=True, verbose=True)
Saving "dat.xlsx" to "tests\data\" ... Done.

>>> dat_pathname = cd(data_dir, "dat.txt")
>>> save_data(dat, dat_pathname, index=True, verbose=True)
Saving "dat.txt" to "tests\data\" ... Done.

>>> dat_pathname = cd(data_dir, "dat.feather")
>>> save_data(dat, dat_pathname, index=True, verbose=True)
Saving "dat.feather" to "tests\data\" ... Done.

>>> # Convert `dat` to JSON format
>>> import json

>>> dat_ = json.loads(dat.to_json(orient='index'))
>>> dat_
{'London': {'Longitude': -0.1276474, 'Latitude': 51.5073219},
 'Birmingham': {'Longitude': -1.9026911, 'Latitude': 52.4796992},
 'Manchester': {'Longitude': -2.2451148, 'Latitude': 53.4794892},
 'Leeds': {'Longitude': -1.5437941, 'Latitude': 53.7974185}}

>>> dat_pathname = cd(data_dir, "dat.json")
>>> save_data(dat_, dat_pathname, indent=4, verbose=True)
Saving "dat.json" to "tests\data\" ... Done.

```

See also:

- Examples for the function `pyhelpers.store.load_data()`.

3.4.2 Data loading

<code>load_pickle(path_to_pickle[, verbose])</code>	Load data from a Pickle file.
<code>load_csv(path_to_csv[, delimiter, header, ...])</code>	Load data from a CSV file.
<code>load_spreadsheets(path_to_spreadsheet[, ...])</code>	Load multiple sheets of an Microsoft Excel file.
<code>load_json(path_to_json[, method, verbose])</code>	Load data from a JSON file.
<code>load_joblib(path_to_joblib[, verbose])</code>	Load data from a joblib file.
<code>load_feather(path_to_feather[, verbose, index])</code>	Load a dataframe from a Feather file.
<code>load_data(path_to_file[, warning])</code>	Load data from a file.

load_pickle

`pyhelpers.store.load_pickle(path_to_pickle, verbose=False, **kwargs)`

Load data from a [Pickle](#) file.

Parameters

- **path_to_pickle** (*str* or *os.PathLike[str]*) – path where a pickle file is saved
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of [pickle.load](#)

Returns data retrieved from the specified path `path_to_pickle`

Return type any

Note:

- Example data can be referred to the function `pyhelpers.store.save_pickle()`.
-

Examples:

```
>>> from pyhelpers.store import load_pickle
>>> from pyhelpers.dir import cd

>>> pickle_pathname = cd("tests\data", "dat.pickle")
>>> pickle_dat = load_pickle(pickle_pathname, verbose=True)
Loading "tests\data\dat.pickle" ... Done.
>>> pickle_dat
```

	Longitude	Latitude
City		
London	-0.127647	51.507322
Birmingham	-1.902691	52.479699
Manchester	-2.245115	53.479489
Leeds	-1.543794	53.797418

load_csv

`pyhelpers.store.load_csv(path_to_csv, delimiter=',', header=0, index=None, verbose=False, **kwargs)`

Load data from a [CSV](#) file.

Parameters

- **path_to_csv** (*str* or *os.PathLike[str]*) – path where a [CSV](#) file is saved
- **delimiter** (*str*) – delimiter used between values in the data file, defaults to `'`, `'`
- **header** (*int* or *List[int]* or *None*) – index number of the rows used as column names, defaults to `0`

- **index** (*str or int or list or None*) – index number of the column(s) to use as the row labels of the dataframe, defaults to `None`
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of `csv.reader`

Returns data retrieved from the specified path `path_to_csv`

Return type `pandas.DataFrame` or `None`

Note:

- Example data can be referred to the function `pyhelpers.store.save_spreadsheet()`.
-

Examples:

```
>>> from pyhelpers.store import load_csv
>>> from pyhelpers.dir import cd

>>> csv_pathname = cd("tests\data", "dat.csv")
>>> csv_dat = load_csv(csv_pathname, index=0, verbose=True)
Loading "tests\data\dat.csv" ... Done.
>>> csv_dat
```

	Longitude	Latitude
City		
London	-0.1276474	51.5073219
Birmingham	-1.9026911	52.4796992
Manchester	-2.2451148	53.4794892
Leeds	-1.5437941	53.7974185

```
>>> csv_pathname = cd("tests\data", "dat.txt")
>>> csv_dat = load_csv(csv_pathname, index=0, verbose=True)
Loading "tests\data\dat.txt" ... Done.
>>> csv_dat
```

	Longitude	Latitude
City		
London	-0.1276474	51.5073219
Birmingham	-1.9026911	52.4796992
Manchester	-2.2451148	53.4794892
Leeds	-1.5437941	53.7974185

```
>>> csv_dat = load_csv(csv_pathname, header=[0, 1], verbose=True)
Loading "tests\data\dat.txt" ... Done.
>>> csv_dat
```

	City	Easting	Northing
	London	530034	180381
0	Birmingham	406689	286822
1	Manchester	383819	398052
2	Leeds	582044	152953

load_spreadsheets

`pyhelpers.store.load_spreadsheets(path_to_spreadsheet, as_dict=True, verbose=False, **kwargs)`

Load multiple sheets of an [Microsoft Excel](#) file.

Parameters

- **path_to_spreadsheet** (*str* or *os.PathLike[str]*) – path where a spreadsheet is saved
- **as_dict** (*bool*) – whether to return the retrieved data as a dictionary type, defaults to `True`
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of [pandas.ExcelFile.parse](#)

Returns all worksheet in an Excel workbook from the specified file path
`path_to_spreadsheet`

Return type list or dict

Note:

- Example data can be referred to the functions
`pyhelpers.store.save_multiple_spreadsheets()` and
`pyhelpers.store.save_spreadsheet()`.
-

Examples:

```
>>> from pyhelpers.store import load_spreadsheets
>>> from pyhelpers.dir import cd

>>> dat_dir = cd("tests\data")
>>> path_to_xlsx = cd(dat_dir, "dat.xlsx")

>>> wb_data = load_spreadsheets(path_to_xlsx, verbose=True, index_col=0)
Loading "tests\data\dat.xlsx" ...
'TestSheet1'. ... Done.
'TestSheet2'. ... Done.
'TestSheet11'. ... Done.
'TestSheet21'. ... Done.
>>> list(wb_data.keys())
['TestSheet1', 'TestSheet2', 'TestSheet11', 'TestSheet21']

>>> wb_data = load_spreadsheets(path_to_xlsx, as_dict=False, index_col=0)
>>> type(wb_data)
list
>>> len(wb_data)
4
>>> wb_data[0]
      Longitude  Latitude
City
London      -0.127647  51.507322
```

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Birmingham	-1.902691	52.479699
Manchester	-2.245115	53.479489
Leeds	-1.543794	53.797418

load_json

`pyhelpers.store.load_json(path_to_json, method=None, verbose=False, **kwargs)`

Load data from a [JSON](#) file.

Parameters

- **path_to_json** (*str* or *os.PathLike[str]*) – path where a json file is saved
- **method** (*str* or *None*) – an open-source Python package for JSON serialization, options include *None* (default, for the built-in [json module](#)), 'ujson' (for [UltraJSON](#)), 'orjson' (for [orjson](#)) and 'rapidjson' (for [python-rapidjson](#))
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to *False*
- **kwargs** – [optional] parameters of [json.load\(\)](#) (if *method=None*), [orjson.loads\(\)](#) (if *method='orjson'*), [ujson.load\(\)](#) (if *method='ujson'*) or [rapidjson.load\(\)](#) (if *method='rapidjson'*)

Returns data retrieved from the specified path *path_to_json*

Return type dict

Note:

- Example data can be referred to the function `pyhelpers.store.save_json()`.

Examples:

```
>>> from pyhelpers.store import load_json
>>> from pyhelpers.dir import cd

>>> json_path = cd("tests\data", "dat.json")
>>> json_dat = load_json(json_path, verbose=True)
Loading "tests\data\dat.json" ... Done.
>>> json_dat
{'London': {'Longitude': -0.1276474, 'Latitude': 51.5073219},
 'Birmingham': {'Longitude': -1.9026911, 'Latitude': 52.4796992},
 'Manchester': {'Longitude': -2.2451148, 'Latitude': 53.4794892},
 'Leeds': {'Longitude': -1.5437941, 'Latitude': 53.7974185}}
```

load_joblib

`pyhelpers.store.load_joblib(path_to_joblib, verbose=False, **kwargs)`

Load data from a [joblib](#) file.

Parameters

- `path_to_joblib` (*str* or *os.PathLike[str]*) – path where a joblib file is saved
- `verbose` (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- `kwargs` – [optional] parameters of [joblib.load](#)

Returns data retrieved from the specified path `path_to_joblib`

Return type any

Note:

- Example data can be referred to the function `pyhelpers.store.save_joblib()`.
-

Examples:

```
>>> from pyhelpers.store import load_joblib
>>> from pyhelpers.dir import cd

>>> joblib_pathname = cd("tests\data", "dat.joblib")
>>> joblib_dat = load_joblib(joblib_pathname, verbose=True)
Loading "tests\data\dat.joblib" ... Done.
>>> joblib_dat
array([[0.5488135 , 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.5736796 , 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.1419334 ],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
        0.81357508]])
```


load_feather

`pyhelpers.store.load_feather(path_to_feather, verbose=False, index=None, **kwargs)`

Load a dataframe from a [Feather](#) file.

Parameters

- **path_to_feather** (*str* or *os.PathLike[str]*) – path where a feather file is saved
- **index** (*str* or *int* or *list* or *None*) – index number of the column(s) to use as the row labels of the dataframe, defaults to *None*
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to *False*
- **kwargs** – [optional] parameters of [pandas.read_feather](#)
 - **columns**: a sequence of column names, if *None*, all columns
 - **use_threads**: whether to parallelize reading using multiple threads, defaults to *True*

Returns data retrieved from the specified path `path_to_feather`

Return type `pandas.DataFrame`

Note:

- Example data can be referred to the function `pyhelpers.store.save_feather()`.
-

Examples:

```
>>> from pyhelpers.store import load_feather
>>> from pyhelpers.dir import cd

>>> feather_path = cd("tests\data", "dat.feather")
>>> feather_dat = load_feather(feather_path, index=0, verbose=True)
Loading "tests\data\dat.feather" ... Done.
>>> feather_dat
```

	Longitude	Latitude
City		
London	-0.127647	51.507322
Birmingham	-1.902691	52.479699
Manchester	-2.245115	53.479489
Leeds	-1.543794	53.797418

load_data

`pyhelpers.store.load_data(path_to_file, warning=True, **kwargs)`

Load data from a file.

Parameters

- **path_to_file** (*str* or *os.PathLike[str]*) – pathname of a file; supported file formats include [Pickle](#), [CSV](#), [Microsoft Excel](#) spreadsheet, [JSON](#), [Joblib](#) and [Feather](#)
- **warning** (*bool*) – whether to show a warning messages, defaults to `True`
- **kwargs** – [optional] parameters of one of the following functions: `load_pickle()`, `load_csv()`, `load_multiple_spreadsheets()`, `load_json()`, `load_joblib()` or `load_feather()`

Returns loaded data

Return type any

Note:

- Example data can be referred to the function `pyhelpers.store.save_data()`.
-

Examples:

```
>>> from pyhelpers.store import load_data
>>> from pyhelpers.dir import cd

>>> data_dir = cd("tests\data")

>>> dat_pathname = cd(data_dir, "dat.pickle")
>>> pickle_dat = load_data(path_to_file=dat_pathname, verbose=True)
Loading "tests\data\dat.pickle" ... Done.
>>> pickle_dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> dat_pathname = cd(data_dir, "dat.pickle")
>>> csv_dat = load_data(path_to_file=dat_pathname, verbose=True)
Loading "tests\data\dat.csv" ... Done.
>>> csv_dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> dat_pathname = cd(data_dir, "dat.json")
```

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```

>>> json_dat = load_data(path_to_file=dat_pathname, verbose=True)
Loading "tests\data\dat.json" ... Done.
>>> json_dat
{'London': {'Longitude': -0.1276474, 'Latitude': 51.5073219},
 'Birmingham': {'Longitude': -1.9026911, 'Latitude': 52.4796992},
 'Manchester': {'Longitude': -2.2451148, 'Latitude': 53.4794892},
 'Leeds': {'Longitude': -1.5437941, 'Latitude': 53.7974185}}

>>> dat_pathname = cd(data_dir, "dat.feather")
>>> feather_dat = load_data(path_to_file=dat_pathname, index=0, verbose=True)
Loading "tests\data\dat.feather" ... Done.
>>> feather_dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691   52.479699
Manchester  -2.245115   53.479489
Leeds       -1.543794   53.797418

>>> dat_pathname = cd(data_dir, "dat.joblib")
>>> joblib_dat = load_data(path_to_file=dat_pathname, verbose=True)
Loading "tests\data\dat.joblib" ... Done.
>>> joblib_dat
array([[0.5488135 , 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.5736796 , 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.1419334 ],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
        0.81357508]])

```

3.4.3 File decompression

<code>unzip(path_to_zip_file[, out_dir, verbose])</code>	Extract data from a zipped (compressed) file.
<code>seven_zip(path_to_zip_file[, out_dir, mode, ...])</code>	Extract data from a compressed file by using 7-Zip .

unzip

`pyhelpers.store.unzip(path_to_zip_file, out_dir=None, verbose=False, **kwargs)`

Extract data from a [zipped](#) (compressed) file.

Parameters

- `path_to_zip_file` (*str*) – path where a Zip file is saved
- `out_dir` (*str* or *None*) – path to a directory where the extracted data is saved, defaults to *None*
- `verbose` (*bool* or *int*) – whether to print relevant information in console, defaults to *False*
- `kwargs` – [optional] parameters of [zipfile.ZipFile.extractall](#)

Examples:

```
>>> from pyhelpers.store import unzip
>>> from pyhelpers.dir import cd, delete_dir

>>> zip_file_path = cd("tests\data", "zipped.zip")

>>> unzip(path_to_zip_file=zip_file_path, verbose=True)
Extracting "tests\data\zipped.zip" to "tests\data\zipped\" ... Done.
>>> out_file_pathname = cd("tests\data\zipped", "zipped.txt")
>>> with open(out_file_pathname) as f:
...     print(f.read())
test

>>> output_dir = cd("tests\data\zipped_alt")
>>> unzip(path_to_zip_file=zip_file_path, out_dir=output_dir, verbose=True)
Extracting "tests\data\zipped.zip" to "tests\data\zipped_alt\" ... Done.
>>> out_file_pathname = cd("tests\data\zipped_alt", "zipped.txt")
>>> with open(out_file_pathname) as f:
...     print(f.read())
test

>>> # Delete the directories "tests\data\zipped\" and "tests\data\zipped_alt\"
>>> delete_dir([cd("tests\data\zipped"), output_dir], verbose=True)
To delete the following directories:
    "tests\data\zipped\" (Not empty)
    "tests\data\zipped_alt\" (Not empty)
? [No]|Yes: yes
Deleting "tests\data\zipped\" ... Done.
Deleting "tests\data\zipped_alt\" ... Done.
```

seven_zip

```
pyhelpers.store.seven_zip(path_to_zip_file, out_dir=None, mode='aoa', verbose=False,
                          seven_zip_exe=None, **kwargs)
```

Extract data from a compressed file by using 7-Zip.

Parameters

- **path_to_zip_file** (*str*) – path where a compressed file is saved
- **out_dir** (*str* or *None*) – path to a directory where the extracted data is saved, defaults to *None*
- **mode** (*str*) – defaults to 'aoa'
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to *False*
- **seven_zip_exe** (*str* or *None*) – absolute path to '7z.exe', defaults to *None*; when *seven_zip_exe=None*, use the default installation path, e.g. (on Windows) "C:\Program Files\7-Zip\7z.exe"
- **kwargs** – [optional] parameters of `subprocess.run`

Examples:

```
>>> from pyhelpers.store import seven_zip
>>> from pyhelpers.dir import cd, delete_dir

>>> zip_file_pathname = cd("tests\data", "zipped.zip")

>>> seven_zip(path_to_zip_file=zip_file_pathname, verbose=True)
7-Zip 20.00 alpha (x64) : Copyright (c) 1999-2020 Igor Pavlov : 2020-02-06

Scanning the drive for archives:
1 file, 158 bytes (1 KiB)

Extracting archive: \tests\data\zipped.zip
--
Path = \tests\data\zipped.zip
Type = zip
Physical Size = 158

Everything is Ok

Size:          4
Compressed: 158

Done.

>>> out_file_pathname = cd("tests\data\zipped", "zipped.txt")
>>> with open(out_file_pathname) as f:
...     print(f.read())
test

>>> output_dir = cd("tests\data\zipped_alt")
>>> seven_zip(path_to_zip_file=zip_file_pathname, out_dir=output_dir, verbose=False)
```

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```

>>> out_file_pathname = cd("tests\data\zipped_alt", "zipped.txt")
>>> with open(out_file_pathname) as f:
...     print(f.read())
test

>>> # Extract a .7z file
>>> zip_file_path = cd("tests\data", "zipped.7z")
>>> seven_zip(path_to_zip_file=zip_file_path, out_dir=output_dir)

>>> out_file_pathname = cd("tests\data\zipped", "zipped.txt")
>>> with open(out_file_pathname) as f:
...     print(f.read())
test

>>> # Delete the directories "tests\data\zipped\" and "tests\data\zipped_alt\"
>>> delete_dir([cd("tests\data\zipped"), output_dir], verbose=True)
To delete the following directories:
    "tests\data\zipped\" (Not empty)
    "tests\data\zipped_alt\" (Not empty)
? [No]|Yes: yes
Deleting "tests\data\zipped\" ... Done.
Deleting "tests\data\zipped_alt\" ... Done.

```

3.4.4 File conversion

<code>markdown_to_rst</code> (<code>path_to_md</code> , <code>path_to_rst</code> [, ...])	Convert a Markdown file (.md) to a reStructuredText (.rst) file.
<code>xlsx_to_csv</code> (<code>xlsx_pathname</code> [, <code>csv_pathname</code> , ...])	Convert Microsoft Excel spreadsheet (in the format .xlsx/.xls) to a CSV file.

markdown_to_rst

`pyhelpers.store.markdown_to_rst`(`path_to_md`, `path_to_rst`, `method=None`, `pandoc_exe=None`,
`verbose=False`, `**kwargs`)

Convert a [Markdown](#) file (.md) to a [reStructuredText](#) (.rst) file.

This function relies on [Pandoc](#) or [pypandoc](#).

Parameters

- `path_to_md` (*str*) – path where a markdown file is saved
- `path_to_rst` (*str*) – path where a reStructuredText file is saved
- `method` (*None* or *str*) – method used for performing the conversion, defaults to *None*; an alternative option is 'pypandoc'
- `pandoc_exe` (*str* or *None*) – absolute path to the executable “pandoc.exe”, defaults to *None*; when `pandoc_exe=None`, use the default installation path, e.g. (on Windows) “C:\Program Files\Pandoc\pandoc.exe”

- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of `subprocess.run` (when `method=None`) or `py pandoc.convert_file` (when `method='py pandoc'`)

Examples:

```
>>> from pyhelpers.store import markdown_to_rst
>>> from pyhelpers.dir import cd

>>> dat_dir = cd("tests\documents")

>>> path_to_md_file = cd(dat_dir, "readme.md")
>>> path_to_rst_file = cd(dat_dir, "readme.rst")

>>> markdown_to_rst(path_to_md_file, path_to_rst_file, verbose=True)
Converting "tests\data\markdown.md" to "tests\data\markdown.rst" ... Done.
```

xlsx_to_csv

`pyhelpers.store.xlsx_to_csv(xlsx_pathname, csv_pathname=None, method=None, if_exists='replace', vbscript=None, sheet_name='1', ret_null=False, verbose=False, **kwargs)`

Convert Microsoft Excel spreadsheet (in the format .xlsx/.xls) to a CSV file.

See also [STORE-[XTC-1](#)].

Parameters

- **xlsx_pathname** (*str*) – pathname of an Excel spreadsheet (in the format of .xlsx)
- **csv_pathname** (*str* or *None*) – pathname of a CSV format file; when `csv_pathname=None` (default), the target CSV file is generated as a `tempfile.NamedTemporaryFile`; when `csv_pathname=""`, the target CSV file is generated at the same directory where the source Excel spreadsheet is; otherwise, it could also be a specific pathname
- **method** (*str* or *None*) – method used for converting .xlsx/.xls to .csv; when `method=None` (default), a Microsoft VBScript (Visual Basic Script) is used; when `method='xlsx2csv'`, the function would rely on `xlsx2csv`
- **if_exists** (*str*) – how to proceed if the target `csv_pathname` exists, defaults to 'replace'
- **vbscript** (*str* or *None*) – pathname of a VB script used for converting .xlsx/.xls to .csv, defaults to `None`
- **sheet_name** (*str*) – name of the target worksheet in the given Excel file, defaults to '1'
- **ret_null** – whether to return something depending on the specified method, defaults to `False`

- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`
- **kwargs** – [optional] parameters of the function `subprocess.run`

Returns the pathname of the generated CSV file or `None`, when `method=None`; `io.StringIO` buffer, when `method='xlsx2csv'`

Return type `str` or `_io.StringIO` or `None`

Examples:

```
>>> from pyhelpers.store import xlsx_to_csv, load_csv
>>> from pyhelpers.dir import cd
>>> import os

>>> path_to_test_xlsx = cd("tests\data", "dat.xlsx")

>>> path_to_temp_csv = xlsx_to_csv(path_to_test_xlsx)
>>> os.path.exists(path_to_temp_csv)
True

>>> load_csv(path_to_temp_csv, index=0)
      Longitude  Latitude
City
London      -0.1276474  51.5073219
Birmingham -1.9026911  52.4796992
Manchester  -2.2451148  53.4794892
Leeds       -1.5437941  53.7974185

>>> os.remove(path_to_temp_csv) # Remove the temporary CSV file
```

3.5 geom

Manipulation of geometric/geographical data.

3.5.1 Geometric data transformation

Geometric type

<code>transform_geom_point_type(*pts[, as_geom])</code>	Transform iterable to <code>shapely.geometry.Point</code> type, or the other way round.
---	---

transform_geom_point_type

`pyhelpers.geom.transform_geom_point_type(*pts, as_geom=True)`

Transform iterable to [shapely.geometry.Point](#) type, or the other way round.

Parameters

- **pts** (*list or tuple or shapely.geometry.Point*) – data of points (e.g. list of lists/tuples)
- **as_geom** (*bool*) – whether to return point(s) as [shapely.geometry.Point](#), defaults to True

Returns a sequence of points (incl. None if errors occur)

Return type *Generator*[[shapely.geometry.Point](#), list, tuple, `numpy.ndarray`]

Examples:

```
>>> from pyhelpers.geom import transform_geom_point_type
>>> from pyhelpers._cache import example_dataframe
>>> from shapely.geometry import Point

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> pt1 = example_df.loc['London'].values # array([-0.1276474,  51.5073219])
>>> pt2 = example_df.loc['Birmingham'].values # array([-1.9026911,  52.4796992])

>>> geom_points = transform_geom_point_type(pt1, pt2)
>>> for x in geom_points:
...     print(x)
POINT (-0.1276474 51.5073219)
POINT (-1.9026911 52.4796992)

>>> geom_points = transform_geom_point_type(pt1, pt2, as_geom=False)
>>> for x in geom_points:
...     print(x)
[-0.1276474 51.5073219]
[-1.9026911 52.4796992]

>>> pt1, pt2 = map(Point, (pt1, pt2))

>>> geom_points = transform_geom_point_type(pt1, pt2)
>>> for x in geom_points:
...     print(x)
POINT (-0.1276474 51.5073219)
POINT (-1.9026911 52.4796992)

>>> geom_points = transform_geom_point_type(pt1, pt2, as_geom=False)
>>> for x in geom_points:
...     print(x)
```

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```
(-0.1276474, 51.5073219)
(-1.9026911, 52.4796992)
```

Coordinate system

<code>wgs84_to_osgb36(longitudes, latitudes[, ...])</code>	Convert latitude and longitude (WGS84) to British national grid (OSGB36).
<code>osgb36_to_wgs84(eastings, northings[, as_array])</code>	Convert British national grid (OSGB36) to latitude and longitude (WGS84).

wgs84_to_osgb36

`pyhelpers.geom.wgs84_to_osgb36(longitudes, latitudes, as_array=False, **kwargs)`

Convert latitude and longitude (WGS84) to British national grid (OSGB36).

Parameters

- **longitudes** (*int or float or Iterable[int, float]*) – the longitude (abbr: long., λ , or lambda) of a point on Earth's surface
- **latitudes** (*int or float or Iterable[int, float]*) – the latitude (abbr: lat., ϕ , or phi) of a point on Earth's surface
- **as_array** (*bool*) – whether to return an array, defaults to False
- **kwargs** – [optional] parameters of `pyproj.Transformer.transform`

Returns geographic Cartesian coordinate (Easting, Northing) or (X, Y)

Return type tuple

Examples:

```
>>> from pyhelpers.geom import wgs84_to_osgb36
>>> from pyhelpers._cache import example_dataframe

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> lon, lat = example_df.loc['London'].values
>>> x, y = wgs84_to_osgb36(longitudes=lon, latitudes=lat)
>>> print(f"London (Easting, Northing): {(x, y)}")
London (Easting, Northing): (530039.558844505, 180371.68016544735)
```

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```

>>> lonlat_array = example_df.to_numpy()
>>> lonlat_array
array([[ -0.1276474,  51.5073219],
       [-1.9026911,  52.4796992],
       [-2.2451148,  53.4794892],
       [-1.5437941,  53.7974185]])

>>> lons, lats = lonlat_array.T # lonlat_array[:, 0], lonlat_array[:, 1]
>>> xs, ys = wgs84_to_osgb36(longitudes=lons, latitudes=lats)
>>> xs
array([530039.5588445 , 406705.8870136 , 383830.03903573, 430147.44735387])
>>> ys
array([180371.68016545, 286868.16664219, 398113.05583091, 433553.32711728])

>>> xy_array = wgs84_to_osgb36(longitudes=lons, latitudes=lats, as_array=True)
>>> xy_array
array([[530039.5588445 , 180371.68016545],
       [406705.8870136 , 286868.16664219],
       [383830.03903573, 398113.05583091],
       [430147.44735387, 433553.32711728]])

```

osgb36_to_wgs84

`pyhelpers.geom.osgb36_to_wgs84(eastings, northings, as_array=False, **kwargs)`

Convert British national grid (**OSGB36**) to latitude and longitude (**WGS84**).

Parameters

- **eastings** (*int or float or Iterable[int, float]*) – Easting (X), eastward-measured distance (or the x-coordinate)
- **northings** (*int or float or Iterable[int, float]*) – Northing (Y), northward-measured distance (or the y-coordinate)
- **as_array** (*bool*) – whether to return an array, defaults to False
- **kwargs** – [optional] parameters of `pyproj.Transformer.transform`

Returns geographic coordinate (Longitude, Latitude)

Return type tuple

Examples:

```

>>> from pyhelpers.geom import osgb36_to_wgs84
>>> from pyhelpers._cache import example_dataframe

>>> example_df = example_dataframe(osgb36=True)
>>> example_df

```

	Easting	Northing
City		
London	530039.558844	180371.680166
Birmingham	406705.887014	286868.166642
Manchester	383830.039036	398113.055831

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```

Leeds          430147.447354  433553.327117

>>> x, y = example_df.loc['London'].values
>>> lon, lat = osgb36_to_wgs84(eastings=x, northings=y)
>>> print(f"London (Longitude, Latitude): {(lon, lat)}")
London (Longitude, Latitude): (-0.12764738749567286, 51.50732189539607)

>>> xy_array = example_df.to_numpy()
>>> xs, ys = xy_array.T # xy_array[:, 0], xy_array[:, 1]
>>> lons, lats = osgb36_to_wgs84(eastings=xs, northings=ys)
>>> lons
array([-0.12764739, -1.90269109, -2.24511479, -1.54379409])
>>> lats
array([51.5073219, 52.4796992, 53.4794892, 53.7974185])

>>> lonlat_array = osgb36_to_wgs84(eastings=xs, northings=ys, as_array=True)
>>> lonlat_array
array([[ -0.12764739,  51.5073219 ],
       [-1.90269109,  52.4796992 ],
       [-2.24511479,  53.4794892 ],
       [-1.54379409,  53.7974185 ]])

```

Dimension / Projection

<code>drop_axis(geom[, axis, as_array])</code>	Drop an axis from a given 3D geometry object.
<code>project_point_to_line(point, line[, ...])</code>	Find the projected point from a known point to a line.

drop_axis

`pyhelpers.geom.drop_axis(geom, axis='z', as_array=False)`

Drop an axis from a given 3D geometry object.

Parameters

- **geom** (*shapely.geometry object*) – geometry object that has x, y and z coordinates
- **axis** (*str*) – options include 'x', 'y' and 'z', defaults to 'z'
- **as_array** (*bool*) – whether to return an array, defaults to False

Returns geometry object (or an array) without the specified axis

Return type shapely.geometry object or numpy.ndarray

Examples:

```

>>> from pyhelpers.geom import drop_axis
>>> from shapely.geometry import Point, LineString, Polygon, MultiLineString

>>> geom_1 = Point([1, 2, 3])

```

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```

>>> geom_1.wkt
'POINT Z (1 2 3)'
>>> geom_1_ = drop_axis(geom_1, 'x')
>>> geom_1_.wkt
'POINT (2 3)'
>>> geom_1_ = drop_axis(geom_1, 'x', as_array=True)
>>> geom_1_
array([2., 3.])

>>> geom_2 = LineString([[1, 2, 3], [2, 3, 4], [3, 4, 5]])
>>> geom_2.wkt
'LINESTRING Z (1 2 3, 2 3 4, 3 4 5)'
>>> geom_2_ = drop_axis(geom_2, 'y')
>>> geom_2_.wkt
'LINESTRING (1 3, 2 4, 3 5)'
>>> geom_2_ = drop_axis(geom_2, 'y', as_array=True)
>>> geom_2_
array([[1., 3.],
       [2., 4.],
       [3., 5.]])

>>> geom_3 = Polygon([[6, 3, 5], [6, 3, 0], [6, 1, 0], [6, 1, 5], [6, 3, 5]])
>>> geom_3.wkt
'POLYGON Z ((6 3 5, 6 3 0, 6 1 0, 6 1 5, 6 3 5))'
>>> geom_3_ = drop_axis(geom_3, 'z')
>>> geom_3_.wkt
'POLYGON ((6 3, 6 3, 6 1, 6 1, 6 3))'
>>> geom_3_ = drop_axis(geom_3, 'z', as_array=True)
>>> geom_3_
array([[6., 3.],
       [6., 3.],
       [6., 1.],
       [6., 1.],
       [6., 3.]])

>>> ls1 = LineString([[1, 2, 3], [2, 3, 4], [3, 4, 5]])
>>> ls2 = LineString([[2, 3, 4], [1, 2, 3], [3, 4, 5]])
>>> geom_4 = MultiLineString([ls1, ls2])
>>> geom_4.wkt
'MULTILINESTRING Z ((1 2 3, 2 3 4, 3 4 5), (2 3 4, 1 2 3, 3 4 5))'
>>> geom_4_ = drop_axis(geom_4, 'z')
>>> geom_4_.wkt
'MULTILINESTRING ((1 2, 2 3, 3 4), (2 3, 1 2, 3 4))'
>>> geom_4_ = drop_axis(geom_4, 'z', as_array=True)
>>> geom_4_
array([[1., 2.],
       [2., 3.],
       [3., 4.],

       [[2., 3.],
        [1., 2.],
        [3., 4.]])

```

project_point_to_line

`pyhelpers.geom.project_point_to_line(point, line, drop_dimension=None)`

Find the projected point from a known point to a line.

Parameters

- **point** (*shapely.geometry.Point*) – geometry object of a point
- **line** (*shapely.geometry.LineString*) – geometry object of a line
- **drop_dimension** (*str or None*) – which dimension to drop, defaults to None; options include 'x', 'y' and 'z'

Returns the original point (with all or partial dimensions, given drop) and the projected one

Return type tuple

Examples:

```
>>> from pyhelpers.geom import project_point_to_line
>>> from shapely.geometry import Point, LineString, MultiPoint

>>> pt = Point([399297, 655095, 43])
>>> ls = LineString([[399299, 655091, 42], [399295, 655099, 42]])

>>> _, pt_proj = project_point_to_line(point=pt, line=ls)
>>> pt_proj.wkt
'POINT Z (399297 655095 42)'
```

This example is illustrated below (see Fig. 10):

```
>>> import matplotlib.pyplot as plt
>>> from pyhelpers.settings import mpl_preferences

>>> mpl_preferences(font_name='Times New Roman', font_size=12)

>>> fig = plt.figure()
>>> ax = fig.add_subplot(projection='3d')

>>> ls_zs = list(map(lambda c: c[2], ls.coords))
>>> ax.plot(ls.coords.xy[0], ls.coords.xy[1], ls_zs, label='Line')
>>> ax.scatter(pt.x, pt.y, pt.z, label='Point')
>>> ax.scatter(pt_proj.x, pt_proj.y, pt_proj.z, label='Projected point')

>>> for i in MultiPoint([*ls.coords, pt, pt_proj]).geoms:
...     pos = tuple(map(int, i.coords[0]))
...     ax.text(pos[0], pos[1], pos[2], str(pos))

>>> ax.legend(loc=3)
>>> plt.tight_layout()

>>> ax.set_xticklabels([])
>>> ax.set_yticklabels([])
>>> ax.set_zticklabels([])

>>> plt.show()
```

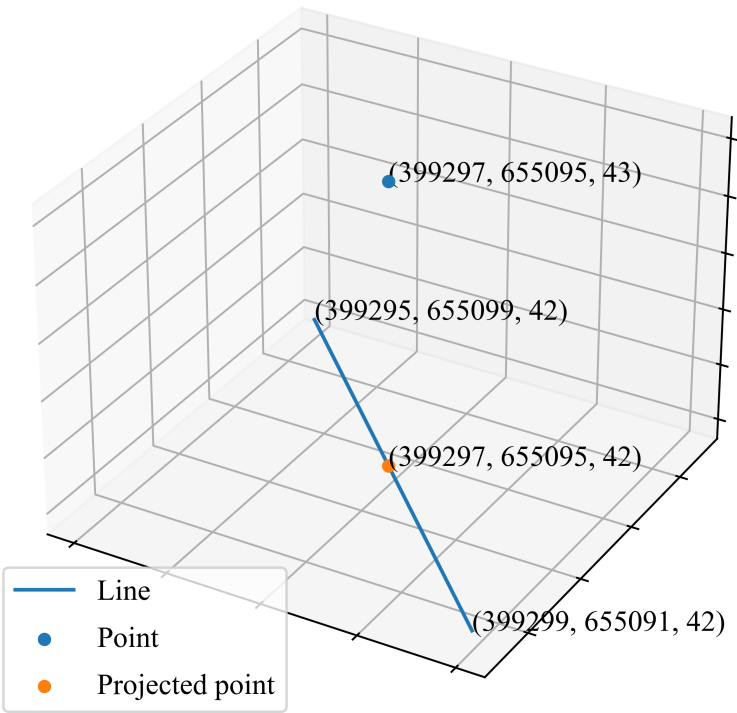


Fig. 10: An example of projecting a point onto a line.

3.5.2 Geometric data computation

Distance

<code>calc_distance_on_unit_sphere(pt1, pt2)</code>	Calculate distance between two points.
<code>calc_hypotenuse_distance(pt1, pt2)</code>	Calculate hypotenuse given two points (the right-angled triangle, given its side and perpendicular).
<code>find_closest_point(pt, ref_pts[, as_geom])</code>	Find the closest point of the given point to a list of points.
<code>find_closest_points(pts, ref_pts[, k, ...])</code>	Find the closest points from a list of reference points (applicable for vectorized computation).
<code>find_shortest_path(points_sequence[, ...])</code>	Find the shortest path through a sequence of points.

calc_distance_on_unit_sphere

`pyhelpers.geom.calc_distance_on_unit_sphere(pt1, pt2)`

Calculate distance between two points.

Parameters

- **pt1** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*)
– a point
- **pt2** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*)
– another point

Returns distance (in miles) between pt1 and pt2 (relative to the earth's radius)

Return type float

Note: This function is modified from the original code available at [\[GEOM-CDOUS-1\]](#). It assumes the earth is perfectly spherical and returns the distance based on each point's longitude and latitude.

Examples:

```
>>> from pyhelpers.geom import calc_distance_on_unit_sphere
>>> from pyhelpers._cache import example_dataframe

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> london, birmingham = example_df.loc[['London', 'Birmingham']].values

>>> arc_len_in_miles = calc_distance_on_unit_sphere(london, birmingham)
>>> arc_len_in_miles
101.10431101941569
```

calc_hypotenuse_distance

`pyhelpers.geom.calc_hypotenuse_distance(pt1, pt2)`

Calculate hypotenuse given two points (the right-angled triangle, given its side and perpendicular).

See also [\[GEOM-CHD-1\]](#).

Parameters

- **pt1** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*)
– a point

- **pt2** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*)
– another point

Returns hypotenuse

Return type float

Note:

- This is the length of the vector from the `orig_pt` to `dest_pt`.
 - `numpy.hypot(x, y)` return the Euclidean norm, `sqrt(x*x + y*y)`.
-

Examples:

```
>>> from pyhelpers.geom import calc_hypotenuse_distance
>>> from shapely.geometry import Point

>>> pt_1, pt_2 = (1.5429, 52.6347), (1.4909, 52.6271)
>>> hypot_distance = calc_hypotenuse_distance(pt_1, pt_2)
>>> hypot_distance
0.05255244999046248

>>> pt_1_, pt_2_ = map(Point, (pt_1, pt_2))
>>> pt_1_.wkt
'POINT (1.5429 52.6347)'
>>> pt_2_.wkt
'POINT (1.4909 52.6271)'
>>> hypot_distance = calc_hypotenuse_distance(pt_1_, pt_2_)
>>> hypot_distance
0.05255244999046248
```

find_closest_point

`pyhelpers.geom.find_closest_point(pt, ref_pts, as_geom=True)`

Find the closest point of the given point to a list of points.

Parameters

- **pt** (*tuple* or *list* or *shapely.geometry.Point*) – (longitude, latitude)
- **ref_pts** (*Iterable* or *shapely.geometry.base.BaseGeometry*) – a sequence of reference (tuple/list of length 2) points
- **as_geom** (*bool*) – whether to return *shapely.geometry.Point*, defaults to `True`

Returns the point closest to `pt`

Return type *shapely.geometry.Point* or *numpy.ndarray*

Examples:

```
>>> from pyhelpers.geom import find_closest_point
>>> from pyhelpers._cache import example_dataframe
```

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```

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> # Find the city closest to London
>>> london = example_df.loc['London'].values
>>> ref_cities = example_df.loc['Birmingham':, :].values
>>> closest_to_london = find_closest_point(pt=london, ref_pts=ref_cities)
>>> closest_to_london.wkt # Birmingham
'POINT (-1.9026911 52.4796992)'

>>> # Find the city closest to Leeds
>>> leeds = example_df.loc['Leeds'].values
>>> ref_cities = example_df.loc[:'Manchester', :].values
>>> closest_to_leeds = find_closest_point(pt=leeds, ref_pts=ref_cities)
>>> closest_to_leeds.wkt # Manchester
'POINT (-2.2451148 53.4794892)'

>>> closest_to_leeds = find_closest_point(pt=leeds, ref_pts=ref_cities, as_geom=False)
>>> closest_to_leeds # Manchester
array([-2.2451148, 53.4794892])

```

find_closest_points

`pyhelpers.geom.find_closest_points(pts, ref_pts, k=1, unique_pts=False, as_geom=False, ret_idx=False, ret_dist=False, **kwargs)`

Find the closest points from a list of reference points (applicable for vectorized computation).

See also [\[GEOM-FCPB-1\]](#).

Parameters

- **pts** (*list or tuple or numpy.ndarray or shapely.geometry.Point or shapely.geometry.MultiPoint or shapely.geometry.LineString*) – an array (of size (n, 2)) of points
- **ref_pts** (*numpy.ndarray or shapely.geometry.MultiPoint or list or tuple*) – an array (of size (n, 2)) of reference points
- **k** (*int or list*) – (up to) the k-th nearest neighbour(s), defaults to 1
- **unique_pts** (*bool*) – whether to remove duplicated points, defaults to False
- **as_geom** (*bool*) – whether to return [shapely.geometry.Point](#), defaults to False
- **ret_idx** (*bool*) – whether to return indices of the closest points in `ref_pts`, defaults to False

- **ret_dist** (*bool*) – whether to return distances between pts and the closest points in ref_pts, defaults to False
- **kwargs** – [optional] parameters of `scipy.spatial.cKDTree`

Returns point (or points) among the list of ref_pts, which is (or are) closest to pts

Return type `numpy.ndarray` or `shapely.geometry.MultiPoint`

Examples:

```
>>> from pyhelpers.geom import find_closest_points
>>> from pyhelpers._cache import example_dataframe
>>> from shapely.geometry import LineString, MultiPoint

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> cities = [[-2.9916800, 53.4071991], # Liverpool
...           [-4.2488787, 55.8609825], # Glasgow
...           [-1.6131572, 54.9738474]] # Newcastle
>>> ref_cities = example_dataframe().to_numpy()

>>> closest_to_each = find_closest_points(pts=cities, ref_pts=ref_cities, k=1)
>>> closest_to_each # Liverpool: Manchester; Glasgow: Manchester; Newcastle: Leeds
array([[ -2.2451148, 53.4794892],
       [ -2.2451148, 53.4794892],
       [ -1.5437941, 53.7974185]])

>>> closest_to_each = find_closest_points(pts=cities, ref_pts=ref_cities, k=1, as_geom=True)
>>> closest_to_each.wkt
'MULTIPOINT (-2.2451148 53.4794892, -2.2451148 53.4794892, -1.5437941 53.7974185)'

>>> _, idx = find_closest_points(pts=cities, ref_pts=ref_cities, k=1, ret_idx=True)
>>> idx
array([2, 2, 3], dtype=int64)

>>> _, _, dist = find_closest_points(cities, ref_cities, k=1, ret_idx=True, ret_dist=True)
>>> dist
array([0.75005697, 3.11232712, 1.17847198])

>>> cities_geoms_1 = LineString(cities)
>>> closest_to_each = find_closest_points(pts=cities_geoms_1, ref_pts=ref_cities, k=1)
>>> closest_to_each
array([[ -2.2451148, 53.4794892],
       [ -2.2451148, 53.4794892],
       [ -1.5437941, 53.7974185]])

>>> cities_geoms_2 = MultiPoint(cities)
>>> closest_to_each = find_closest_points(cities_geoms_2, ref_cities, k=1, as_geom=True)
>>> closest_to_each.wkt
'MULTIPOINT (-2.2451148 53.4794892, -2.2451148 53.4794892, -1.5437941 53.7974185)'
```

find_shortest_path

`pyhelpers.geom.find_shortest_path(points_sequence, ret_dist=False, as_geom=False, **kwargs)`

Find the shortest path through a sequence of points.

Parameters

- **points_sequence** (*numpy.ndarray*) – a sequence of points
- **ret_dist** (*bool*) – whether to return the distance of the shortest path, defaults to `False`
- **as_geom** (*bool*) – whether to return the sorted path as a line geometry object, defaults to `False`
- **kwargs** – (optional) parameters used by [sklearn.neighbors.NearestNeighbors](#)

Returns a sequence of sorted points given two-nearest neighbors

Return type `numpy.ndarray` or `shapely.geometry.LineString` or `tuple`

Examples:

```
>>> from pyhelpers.geom import find_shortest_path
>>> from pyhelpers._cache import example_dataframe

>>> example_df = example_dataframe()
>>> example_df
   Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham  -1.902691  52.479699
Manchester   -2.245115  53.479489
Leeds        -1.543794  53.797418

>>> example_df_ = example_df.sample(frac=1, random_state=1)
>>> example_df_
   Longitude  Latitude
City
Leeds        -1.543794  53.797418
Manchester   -2.245115  53.479489
London      -0.127647  51.507322
Birmingham  -1.902691  52.479699

>>> cities = example_df_.to_numpy()
>>> cities
array([[ -1.5437941,  53.7974185],
       [ -2.2451148,  53.4794892],
       [ -0.1276474,  51.5073219],
       [ -1.9026911,  52.4796992]])

>>> cities_sorted = find_shortest_path(points_sequence=cities)
>>> cities_sorted
array([[ -1.5437941,  53.7974185],
       [ -2.2451148,  53.4794892],
       [ -1.9026911,  52.4796992],
       [ -0.1276474,  51.5073219]])
```

This example is illustrated below (see [Fig. 11](#)):

```

>>> import matplotlib.pyplot as plt
>>> import matplotlib.gridspec as mgs
>>> from pyhelpers.settings import mpl_preferences

>>> mpl_preferences(font_name='Times New Roman')

>>> fig = plt.figure(figsize=(7, 5))
>>> gs = mgs.GridSpec(1, 2, figure=fig)

>>> ax1 = fig.add_subplot(gs[:, 0])
>>> ax1.plot(cities[:, 0], cities[:, 1], label='original')
>>> for city, i, lonlat in zip(example_df.index, range(len(cities)), cities):
...     ax1.scatter(lonlat[0], lonlat[1])
...     ax1.annotate(city + f' ({i})', xy=lonlat + 0.05)
>>> ax1.legend(loc=3)

>>> ax2 = fig.add_subplot(gs[:, 1])
>>> ax2.plot(cities_sorted[:, 0], cities_sorted[:, 1], label='sorted', color='orange')
>>> for city, i, lonlat in zip(example_df.index[::-1], range(len(cities)), cities_sorted):
...     ax2.scatter(lonlat[0], lonlat[1])
...     ax2.annotate(city + f' ({i})', xy=lonlat + 0.05)
>>> ax2.legend(loc=3)

>>> plt.tight_layout()
>>> plt.show()

```

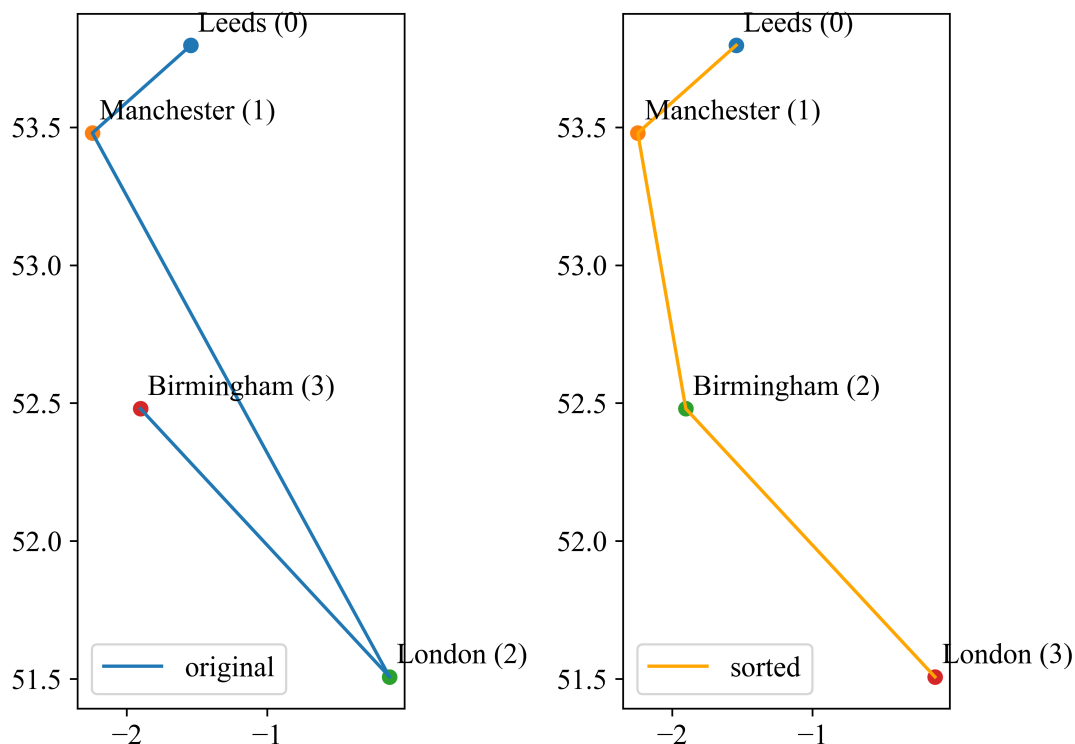


Fig. 11: An example of sorting a sequence of points given the shortest path.

Locating

<code>get_midpoint(x1, y1, x2, y2[, as_geom])</code>	Get the midpoint between two points (applicable for vectorized computation).
<code>get_geometric_midpoint(pt1, pt2[, as_geom])</code>	Get the midpoint between two points.
<code>get_geometric_midpoint_calc(pt1, pt2[, as_geom])</code>	Get the midpoint between two points by pure calculation.
<code>get_rectangle_centroid(rectangle[, as_geom])</code>	Get coordinates of the centroid of a rectangle
<code>get_square_vertices(ctr_x, ctr_y, side_length)</code>	Get the four vertices of a square given its centre and side length.
<code>get_square_vertices_calc(ctr_x, ctr_y, ...)</code>	Get the four vertices of a square given its centre and side length (by elementary calculation).

get_midpoint

`pyhelpers.geom.get_midpoint(x1, y1, x2, y2, as_geom=False)`

Get the midpoint between two points (applicable for vectorized computation).

Parameters

- **x1** (*float or int or Iterable or numpy.ndarray*) – longitude(s) or easting(s) of a point (an array of points)
- **y1** (*float or int or Iterable or numpy.ndarray*) – latitude(s) or northing(s) of a point (an array of points)
- **x2** (*float or int or Iterable or numpy.ndarray*) – longitude(s) or easting(s) of another point (another array of points)
- **y2** (*float or int or Iterable or numpy.ndarray*) – latitude(s) or northing(s) of another point (another array of points)
- **as_geom** (*bool*) – whether to return `shapely.geometry.Point`, defaults to `False`

Returns the midpoint between (x1, y1) and (x2, y2) (or midpoints between two sequences of points)

Return type `numpy.ndarray` or `shapely.geometry.Point` or `shapely.geometry.MultiPoint`

Examples:

```
>>> from pyhelpers.geom import get_midpoint

>>> x_1, y_1 = 1.5429, 52.6347
>>> x_2, y_2 = 1.4909, 52.6271

>>> midpt = get_midpoint(x_1, y_1, x_2, y_2)
>>> midpt
array([ 1.5169, 52.6309])
```

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```

>>> midpt = get_midpoint(x_1, y_1, x_2, y_2, as_geom=True)
>>> midpt.wkt
'POINT (1.5169 52.6309)'

>>> x_1, y_1 = (1.5429, 1.4909), (52.6347, 52.6271)
>>> x_2, y_2 = [2.5429, 2.4909], [53.6347, 53.6271]

>>> midpt = get_midpoint(x_1, y_1, x_2, y_2)
>>> midpt
array([[ 2.0429, 53.1347],
       [ 1.9909, 53.1271]])

>>> midpt = get_midpoint(x_1, y_1, x_2, y_2, as_geom=True)
>>> midpt.wkt
'MULTIPOINT (2.0429 53.1347, 1.9909 53.1271)'

```

get_geometric_midpoint

`pyhelpers.geom.get_geometric_midpoint(pt1, pt2, as_geom=False)`

Get the midpoint between two points.

Parameters

- **pt1** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*) – a point
- **pt2** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*) – another point
- **as_geom** (*bool*) – whether to return *shapely.geometry.Point*, defaults to *False*

Returns the midpoint between pt1 and pt2

Return type *tuple* or *shapely.geometry.Point* or *None*

Examples:

```

>>> from pyhelpers.geom import get_geometric_midpoint

>>> pt_1, pt_2 = (1.5429, 52.6347), (1.4909, 52.6271)

>>> geometric_midpoint = get_geometric_midpoint(pt_1, pt_2)
>>> geometric_midpoint
(1.5169, 52.6309)

>>> geometric_midpoint = get_geometric_midpoint(pt_1, pt_2, as_geom=True)
>>> geometric_midpoint.wkt
'POINT (1.5169 52.6309)'

```

See also:

- Examples for the function `pyhelpers.geom.get_geometric_midpoint_calc()`.

get_geometric_midpoint_calc

`pyhelpers.geom.get_geometric_midpoint_calc(pt1, pt2, as_geom=False)`

Get the midpoint between two points by pure calculation.

See also [\[GEOM-GGMC-1\]](#) and [\[GEOM-GGMC-2\]](#).

Parameters

- **pt1** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*) – a point
- **pt2** (*shapely.geometry.Point* or *list* or *tuple* or *numpy.ndarray*) – a point
- **as_geom** (*bool*) – whether to return *shapely.geometry.Point*. defaults to `False`

Returns the midpoint between pt1 and pt2

Return type *tuple* or *shapely.geometry.Point* or `None`

Examples:

```
>>> from pyhelpers.geom import get_geometric_midpoint_calc

>>> pt_1, pt_2 = (1.5429, 52.6347), (1.4909, 52.6271)

>>> geometric_midpoint = get_geometric_midpoint_calc(pt_1, pt_2)
>>> geometric_midpoint
(1.5168977420748175, 52.630902845583094)

>>> geometric_midpoint = get_geometric_midpoint_calc(pt_1, pt_2, as_geom=True)
>>> geometric_midpoint.wkt
'POINT (1.516897742074818 52.6309028455831)'
```

See also:

- Examples for the function `pyhelpers.geom.get_geometric_midpoint()`.

get_rectangle_centroid

`pyhelpers.geom.get_rectangle_centroid(rectangle, as_geom=False)`

Get coordinates of the centroid of a rectangle

Parameters

- **rectangle** (*numpy.ndarray* or *shapely.geometry.Polygon* or *shapely.geometry.MultiPolygon*) – polygon or multipolygon geometry object
- **as_geom** (*bool*) – whether to return a *shapely.geometry* object

Returns coordinate of the rectangle

Return type *numpy.ndarray* or *shapely.geometry.Point*

Examples:

```
>>> from pyhelpers.geom import get_rectangle_centroid
>>> from shapely.geometry import Polygon

>>> rectangle_obj = Polygon([[0, 0], [0, 1], [1, 1], [1, 0]])

>>> rect_cen = get_rectangle_centroid(rectangle=rectangle_obj)
>>> rect_cen
array([0.5, 0.5])
```

get_square_vertices

pyhelpers.geom.**get_square_vertices**(ctr_x, ctr_y, side_length, rotation_theta=0)

Get the four vertices of a square given its centre and side length.

See also [\[GEOM-GSV-1\]](#).

Parameters

- **ctr_x** (*int or float*) – x coordinate of a square centre
- **ctr_y** (*int or float*) – y coordinate of a square centre
- **side_length** (*int or float*) – side length of a square
- **rotation_theta** (*int or float*) – rotate (anticlockwise) the square by rotation_theta (in degree), defaults to 0

Returns vertices of the square as an array([ll, ul, ur, lr])

Return type numpy.ndarray

Examples:

```
>>> from pyhelpers.geom import get_square_vertices

>>> ctr_1, ctr_2 = -5.9375, 56.8125
>>> side_len = 0.125

>>> vts = get_square_vertices(ctr_1, ctr_2, side_len, rotation_theta=0)
>>> vts
array([[ -6.    , 56.75 ],
       [ -6.    , 56.875],
       [-5.875, 56.875],
       [-5.875, 56.75 ]])

>>> # Rotate the square by 30° (anticlockwise)
>>> vts = get_square_vertices(ctr_1, ctr_2, side_len, rotation_theta=30)
>>> vts
array([[-5.96037659, 56.72712341],
       [-6.02287659, 56.83537659],
       [-5.91462341, 56.89787659],
       [-5.85212341, 56.78962341]])
```

get_square_vertices_calc

`pyhelpers.geom.get_square_vertices_calc(ctr_x, ctr_y, side_length, rotation_theta=0)`

Get the four vertices of a square given its centre and side length (by elementary calculation).

See also [\[GEOM-GSVC-1\]](#).

Parameters

- **ctr_x** (*int or float*) – x coordinate of a square centre
- **ctr_y** (*int or float*) – y coordinate of a square centre
- **side_length** (*int or float*) – side length of a square
- **rotation_theta** (*int or float*) – rotate (anticlockwise) the square by rotation_theta (in degree), defaults to 0

Returns vertices of the square as an array([ll, ul, ur, lr])

Return type numpy.ndarray

Examples:

```
>>> from pyhelpers.geom import get_square_vertices_calc

>>> ctr_1, ctr_2 = -5.9375, 56.8125
>>> side_len = 0.125

>>> vts = get_square_vertices_calc(ctr_1, ctr_2, side_len, rotation_theta=0)
>>> vts
array([[ -6.    , 56.75 ],
       [ -6.    , 56.875],
       [-5.875, 56.875],
       [-5.875, 56.75 ]])

>>> # Rotate the square by 30° (anticlockwise)
>>> vts = get_square_vertices_calc(ctr_1, ctr_2, side_len, rotation_theta=30)
>>> vts
array([[ -5.96037659, 56.72712341],
       [ -6.02287659, 56.83537659],
       [-5.91462341, 56.89787659],
       [-5.85212341, 56.78962341]])
```

See also:

- Examples for the function `pyhelpers.geom.get_square_vertices()`.

3.5.3 Geometric data sketching

<code>sketch_square</code> (ctr_x, ctr_y[, side_length, ...])	Sketch a square given its centre point, four vertices and rotation angle (in degree).
---	---

`sketch_square`

`pyhelpers.geom.sketch_square`(ctr_x, ctr_y, side_length=None, rotation_theta=0, annotation=False, annot_font_size=12, fig_size=(6.4, 4.8), ret_vertices=False, **kwargs)

Sketch a square given its centre point, four vertices and rotation angle (in degree).

Parameters

- **ctr_x** (*int or float*) – x coordinate of a square centre
- **ctr_y** (*int or float*) – y coordinate of a square centre
- **side_length** (*int or float*) – side length of a square
- **rotation_theta** (*int or float*) – rotate (anticlockwise) the square by rotation_theta (in degree), defaults to 0
- **annotation** (*bool*) – whether to annotate vertices of the square, defaults to True
- **annot_font_size** (*int*) – font size annotation texts, defaults to 12
- **fig_size** (*tuple or list*) – figure size, defaults to (6.4, 4.8)
- **ret_vertices** (*bool*) – whether to return the vertices of the square, defaults to False
- **kwargs** – [optional] parameters of `matplotlib.axes.Axes.annotate`

Returns vertices of the square as an array([ll, ul, ur, lr])

Return type `numpy.ndarray`

Examples:

```
>>> from pyhelpers.geom import sketch_square
>>> from pyhelpers.settings import mpl_preferences
>>> import matplotlib.pyplot as plt

>>> mpl_preferences()

>>> c1, c2 = 1, 1
>>> side_len = 2

>>> sketch_square(c1, c2, side_len, rotation_theta=0, annotation=True, fig_size=(5, 5))
>>> plt.show()
```

The above example is illustrated in Fig. 12:

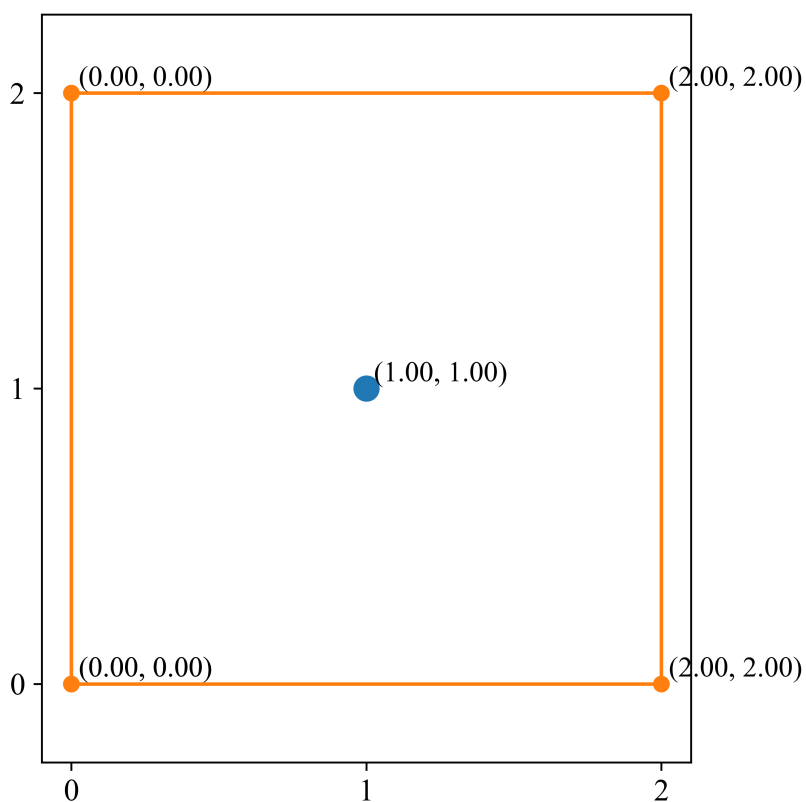


Fig. 12: An example of a sketch of a square, created by the function `sketch_square()`.

```
>>> sketch_square(c1, c2, side_len, rotation_theta=75, annotation=True, fig_size=(5, 5))
>>> plt.show()
```

This second example is illustrated in Fig. 13:

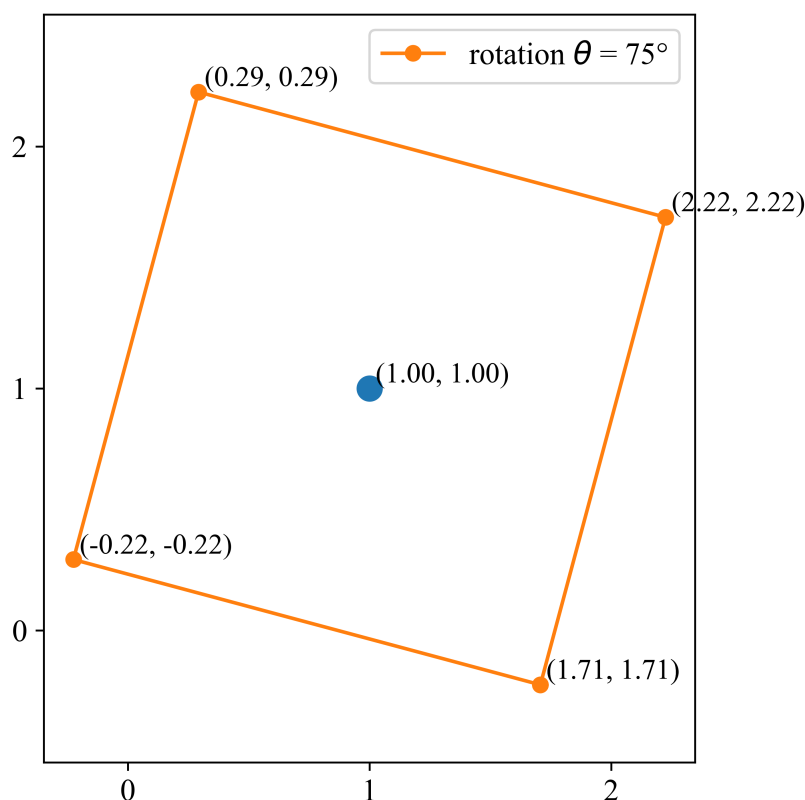


Fig. 13: An example of a sketch of a square rotated 75 degrees anticlockwise about the centre.

3.6 text

Manipulation of textual data.

3.6.1 Textual data preprocessing

<code>get_acronym(text[, only_capitals, ...])</code>	Get an acronym (in capital letters) of an input text.
<code>remove_punctuation(x[, rm_whitespace])</code>	Remove punctuation from string-type data.
<code>extract_words1upper(x[, join_with])</code>	Extract words from a string by splitting it at occurrence of an uppercase letter.
<code>numeral_english_to_arabic(x)</code>	Convert a string which potentially is a number written in English to an Arabic number

get_acronym

`pyhelpers.text.get_acronym(text, only_capitals=False, capitals_in_words=False)`

Get an acronym (in capital letters) of an input text.

Parameters

- **text** (*str*) – any text
- **only_capitals** (*bool*) – whether to include capital letters only, defaults to `False`
- **capitals_in_words** (*bool*) – whether to include all capital letters in a single word, defaults to `False`

Returns acronym of the input `str_var`

Return type `str`

Examples:

```
>>> from pyhelpers.text import get_acronym

>>> text_a = 'This is an apple.'
>>> acron = get_acronym(text_a)
>>> acron
'TIAA'

>>> text_b = "I'm at the University of Birmingham."
>>> acron = get_acronym(text_b, only_capitals=True)
>>> acron
'IUB'

>>> text_c = 'There is a "ConnectionError"!'
>>> acron = get_acronym(text_c, capitals_in_words=True)
>>> acron
'TCE'
```

remove_punctuation

`pyhelpers.text.remove_punctuation(x, rm_whitespace=True)`

Remove punctuation from string-type data.

Parameters

- **x** (*str*) – raw string-type data
- **rm_whitespace** (*bool*) – whether to remove whitespace (incl. escape characters), defaults to `True`

Returns text with punctuation removed

Return type `str`

Examples:

```
>>> from pyhelpers.text import remove_punctuation

>>> raw_text = 'Hello world!   This is a test. :-)'

>>> text = remove_punctuation(raw_text)
>>> text
'Hello world This is a test'

>>> text = remove_punctuation(raw_text, rm_whitespace=False)
>>> text
'Hello world   This is a test'
```

extract_words1upper

pyhelpers.text.extract_words1upper(*x*, *join_with=None*)

Extract words from a string by splitting it at occurrence of an uppercase letter.

Parameters

- **x** (*str*) – a string joined by a number of words each starting with an uppercase letter
- **join_with** (*str* or *None*) – a string with which to (re)join the single words, defaults to *None*

Returns a list of single words each starting with an uppercase letter, or a single string joined together by them with *join_with*

Return type list or str

Examples:

```
>>> from pyhelpers.text import extract_words1upper

>>> x1 = 'Network_Waymarks'
>>> x1_ = extract_words1upper(x1)
>>> x1_
['Network', 'Waymarks']

>>> x2 = 'NetworkRailRetainingWall'
>>> x2_ = extract_words1upper(x2, join_with=' ')
>>> x2_
'Network Rail Retaining Wall'
```

numeral_english_to_arabic

pyhelpers.text.numeral_english_to_arabic(*x*)

Convert a string which potentially is a number written in English to an Arabic number

Parameters **x** (*str*) – a number written in English

Returns a number written in Arabic

Return type int

Examples:

```
>>> from pyhelpers.text import numeral_english_to_arabic

>>> numeral_english_to_arabic('one')
1

>>> numeral_english_to_arabic('one hundred and one')
101

>>> numeral_english_to_arabic('a thousand two hundred and three')
1203

>>> numeral_english_to_arabic('200 and five')
205

>>> numeral_english_to_arabic('Two hundred and fivety') # Two hundred and fifty
Exception: Illegal word: "fivety"
```

3.6.2 Textual data computation

<code>count_words(raw_txt)</code>	Count the total for each different word.
<code>calculate_idf(raw_documents[, rm_punc])</code>	Calculate inverse document frequency.
<code>calculate_tf_idf(raw_documents[, rm_punc])</code>	Count term frequency–inverse document frequency.
<code>euclidean_distance_between_texts(txt1, txt2)</code>	Compute Euclidean distance of two sentences.
<code>cosine_similarity_between_texts(txt1, txt2)</code>	Calculate cosine similarity of two sentences.

count_words

`pyhelpers.text.count_words(raw_txt)`

Count the total for each different word.

Parameters `raw_txt` (*str*) – any text

Returns number of each word in `raw_docs`

Return type dict

Examples:

```
>>> from pyhelpers.text import count_words, remove_punctuation

>>> raw_text = 'This is an apple. That is a pear. Hello world!'

>>> count_words(raw_text)
{'This': 1,
 'is': 2,
 'an': 1,
```

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```
'apple': 1,
'.': 2,
'That': 1,
'a': 1,
'pear': 1,
'Hello': 1,
'world': 1,
'!': 1}

>>> count_words(remove_punctuation(raw_text))
{'This': 1,
 'is': 2,
 'an': 1,
 'apple': 1,
 'That': 1,
 'a': 1,
 'pear': 1,
 'Hello': 1,
 'world': 1}
```

calculate_idf

pyhelpers.text.calculate_idf(*raw_documents*, *rm_punc=False*)

Calculate inverse document frequency.

Parameters

- **raw_documents** (*Iterable* or *Sequence*) – a sequence of textual data
- **rm_punc** (*bool*) – whether to remove punctuation from the input textual data, defaults to False

Returns term frequency (TF) of the input textual data, and inverse document frequency

Return type tuple[list[dict], dict]

Examples:

```
>>> from pyhelpers.text import calculate_idf

>>> raw_doc = [
...     'This is an apple.',
...     'That is a pear.',
...     'It is human being.',
...     'Hello world!']

>>> docs_tf_, corpus_idf_ = calculate_idf(raw_doc, rm_punc=False)
>>> docs_tf_
[{'This': 1, 'is': 1, 'an': 1, 'apple': 1, '.': 1},
 {'That': 1, 'is': 1, 'a': 1, 'pear': 1, '.': 1},
 {'It': 1, 'is': 1, 'human': 1, 'being': 1, '.': 1},
 {'Hello': 1, 'world': 1, '!': 1}]

>>> corpus_idf_
```

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```
{'This': 0.6931471805599453,
 'is': 0.0,
 'an': 0.6931471805599453,
 'apple': 0.6931471805599453,
 '.': 0.0,
 'That': 0.6931471805599453,
 'a': 0.6931471805599453,
 'pear': 0.6931471805599453,
 'It': 0.6931471805599453,
 'human': 0.6931471805599453,
 'being': 0.6931471805599453,
 'Hello': 0.6931471805599453,
 'world': 0.6931471805599453,
 '!': 0.6931471805599453}

>>> docs_tf_, corpus_idf_ = calculate_idf(raw_doc, rm_punc=True)
>>> docs_tf_
[{'This': 1, 'is': 1, 'an': 1, 'apple': 1},
 {'That': 1, 'is': 1, 'a': 1, 'pear': 1},
 {'It': 1, 'is': 1, 'human': 1, 'being': 1},
 {'Hello': 1, 'world': 1}]

>>> corpus_idf_
{'This': 0.6931471805599453,
 'is': 0.0,
 'an': 0.6931471805599453,
 'apple': 0.6931471805599453,
 'That': 0.6931471805599453,
 'a': 0.6931471805599453,
 'pear': 0.6931471805599453,
 'It': 0.6931471805599453,
 'human': 0.6931471805599453,
 'being': 0.6931471805599453,
 'Hello': 0.6931471805599453,
 'world': 0.6931471805599453}
```

calculate_tf_idf

pyhelpers.text.calculate_tf_idf(raw_documents, rm_punc=False)

Count term frequency–inverse document frequency.

Parameters

- **raw_documents** (*Iterable* or *Sequence*) – a sequence of textual data
- **rm_punc** (*bool*) – whether to remove punctuation from the input textual data, defaults to False

Returns tf-idf of the input textual data

Return type dict

Examples:

```

>>> from pyhelpers.text import calculate_tf_idf

>>> raw_doc = [
...     'This is an apple.',
...     'That is a pear.',
...     'It is human being.',
...     'Hello world!']

>>> docs_tf_idf_ = calculate_tf_idf(raw_documents=raw_doc)
>>> docs_tf_idf_
{'This': 0.6931471805599453,
 'is': 0.0,
 'an': 0.6931471805599453,
 'apple': 0.6931471805599453,
 '.': 0.0,
 'That': 0.6931471805599453,
 'a': 0.6931471805599453,
 'pear': 0.6931471805599453,
 'It': 0.6931471805599453,
 'human': 0.6931471805599453,
 'being': 0.6931471805599453,
 'Hello': 0.6931471805599453,
 'world': 0.6931471805599453,
 '!': 0.6931471805599453}

>>> docs_tf_idf_ = calculate_tf_idf(raw_documents=raw_doc, rm_punc=True)
>>> docs_tf_idf_
{'This': 0.6931471805599453,
 'is': 0.0,
 'an': 0.6931471805599453,
 'apple': 0.6931471805599453,
 'That': 0.6931471805599453,
 'a': 0.6931471805599453,
 'pear': 0.6931471805599453,
 'It': 0.6931471805599453,
 'human': 0.6931471805599453,
 'being': 0.6931471805599453,
 'Hello': 0.6931471805599453,
 'world': 0.6931471805599453}

```

euclidean_distance_between_texts

`pyhelpers.text.euclidean_distance_between_texts(txt1, txt2)`

Compute Euclidean distance of two sentences.

Parameters

- `txt1` (*str*) – any text
- `txt2` (*str*) – any text

Returns Euclidean distance between the input textual data

Return type float

Examples:

```
>>> from pyhelpers.text import euclidean_distance_between_texts

>>> txt_1, txt_2 = 'This is an apple.', 'That is a pear.'

>>> euclidean_distance = euclidean_distance_between_texts(txt_1, txt_2)
>>> euclidean_distance
2.449489742783178
```

cosine_similarity_between_texts

`pyhelpers.text.cosine_similarity_between_texts(txt1, txt2, cosine_distance=False)`

Calculate cosine similarity of two sentences.

Parameters

- **txt1** (*str*) – any text
- **txt2** (*str*) – any text
- **cosine_distance** (*bool*) – whether to get cosine distance, which is (1 - cosine similarity), defaults to False

Returns cosine similarity (or distance)

Return type float

Examples:

```
>>> from pyhelpers.text import cosine_similarity_between_texts

>>> txt_1, txt_2 = 'This is an apple.', 'That is a pear.'

>>> cos_sim = cosine_similarity_between_texts(txt_1, txt_2)
>>> cos_sim
0.25

>>> cos_dist = cosine_similarity_between_texts(txt_1, txt_2, cosine_distance=True)
>>> cos_dist # 1 - cos_sim
0.75
```

3.6.3 Textual data comparison

<code>find_matched_str(x, lookup_list)</code>	Find all that are matched with a string from among a sequence of strings.
<code>find_similar_str(x, lookup_list[, n, ...])</code>	From among a sequence of strings, find n ones that are similar to x.

find_matched_str

`pyhelpers.text.find_matched_str(x, lookup_list)`

Find all that are matched with a string from among a sequence of strings.

Parameters

- **x** (*str*) – a string-type variable
- **lookup_list** (*List[str]* or *Tuple[str]* or *Sequence[str]*) – a sequence of strings for lookup

Returns a generator containing all that are matched with x

Return type *Generator* or *None*

Examples:

```
>>> from pyhelpers.text import find_matched_str

>>> lookup_lst = ['abc', 'aapl', 'app', 'ap', 'ape', 'apex', 'apel']
>>> res = find_matched_str('apple', lookup_lst)
>>> list(res)
[]

>>> lookup_lst += ['apple']
>>> lookup_lst
['abc', 'aapl', 'app', 'ap', 'ape', 'apex', 'apel', 'apple']

>>> res = find_matched_str('apple', lookup_lst)
>>> list(res)
['apple']

>>> res = find_matched_str(r'app(le)?', lookup_lst)
>>> list(res)
['app', 'apple']
```

find_similar_str

`pyhelpers.text.find_similar_str(x, lookup_list, n=1, ignore_punctuation=True, method='difflib', **kwargs)`

From among a sequence of strings, find n ones that are similar to x.

Parameters

- **x** (*str*) – a string-type variable
- **lookup_list** (*List[str]* or *Tuple[str]* or *Sequence[str]*) – a sequence of strings for lookup
- **n** (*int* or *None*) – number of similar strings to return, defaults to 1; if n=None, the function returns a sorted lookup_list (in descending order of similarity)
- **method** (*str* or *None*) – options include 'difflib' (default) and 'fuzzywuzzy'

- if method='difflib', the function relies on `difflib.get_close_matches`
- if method='fuzzywuzzy', the function relies on `fuzzywuzzy.fuzz.token_set_ratio`
- **ignore_punctuation** (*bool*) – whether to ignore punctuations in the search for similar texts
- **kwargs** – [optional] parameters of `difflib.get_close_matches` or `fuzzywuzzy.fuzz.token_set_ratio`, depending on processor

Returns a string-type variable that should be similar to (or the same as) x

Return type str or list or None

Examples:

```
>>> from pyhelpers.text import find_similar_str

>>> lookup_lst = ['Anglia',
...               'East Coast',
...               'East Midlands',
...               'North and East',
...               'London North Western',
...               'Scotland',
...               'South East',
...               'Wales',
...               'Wessex',
...               'Western']

>>> str_similar = find_similar_str(x='angle', lookup_list=lookup_lst)
>>> str_similar
'Anglia'
>>> str_similar = find_similar_str(x='angle', lookup_list=lookup_lst, method='fuzzywuzzy')
>>> str_similar
'Anglia'

>>> str_similar = find_similar_str(x='x', lookup_list=lookup_lst)
>>> str_similar # None

>>> str_similar = find_similar_str(x='x', lookup_list=lookup_lst, method='fuzzywuzzy')
>>> str_similar
'Wessex'
```

3.7 dbms

Communication with databases.

The current release includes classes for PostgreSQL and Microsoft SQL Server.

3.7.1 Databases

<code>PostgreSQL</code> ([host, port, username, password, ...])	A class for basic communication with <code>PostgreSQL</code> databases.
<code>MSSQL</code> ([host, port, username, password, ...])	A class for basic communication with <code>Microsoft SQL Server</code> databases.

PostgreSQL

```
class pyhelpers.dbms.PostgreSQL(host=None, port=None, username=None, password=None,
                                database_name=None, confirm_db_creation=False, verbose=True)
```

A class for basic communication with `PostgreSQL` databases.

Parameters

- **host** (*str* or *None*) – host name/address of a PostgreSQL server, e.g. 'localhost' or '127.0.0.1' (default by installation of PostgreSQL); when host=None (default), it is initialized as 'localhost'
- **port** (*int* or *None*) – listening port used by PostgreSQL; when port=None (default), it is initialized as 5432 (default by installation of PostgreSQL)
- **username** (*str* or *None*) – username of a PostgreSQL server; when username=None (default), it is initialized as 'postgres' (default by installation of PostgreSQL)
- **password** (*str* or *int* or *None*) – user password; when password=None (default), it is required to manually type in the correct password to connect the PostgreSQL server
- **database_name** (*str* or *None*) – name of a database; when database=None (default), it is initialized as 'postgres' (default by installation of PostgreSQL)
- **confirm_db_creation** (*bool*) – whether to prompt a confirmation before creating a new database (if the specified database does not exist), defaults to False
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to True

Variables

- **host** (*str*) – host name/address
- **port** (*str*) – listening port used by PostgreSQL
- **username** (*str*) – username
- **database_name** (*str*) – name of a database
- **credentials** (*dict*) – basic information about the server/database being connected

- **address** (*str*) – representation of the database address
- **engine** (*sqlalchemy.engine.Engine*) – [SQLAlchemy](#) connectable engine to a PostgreSQL server; see also [\[DBMS-PS-2\]](#)

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> # Connect the default database 'postgres'
>>> # postgres = PostgreSQL('localhost', 5432, 'postgres', database_name='postgres')
>>> postgres = PostgreSQL()
Password (postgres@localhost:5432): ***
Connecting postgres:***@localhost:5432/postgres ... Successfully.

>>> postgres.address
'postgres:***@localhost:5432/postgres'

>>> # Connect a database 'testdb' (which will be created if it does not exist)
>>> testdb = PostgreSQL(database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.address
'postgres:***@localhost:5432/testdb'

>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

>>> testdb.address
'postgres:***@localhost:5432/postgres'
```

Define a proxy object that inherits from this class:

```
>>> class ExampleProxyObj(PostgreSQL):
...     def __init__(self, **kwargs):
...         super().__init__(**kwargs)

>>> example_proxy = ExampleProxyObj(database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> example_proxy.address
'postgres:***@localhost:5432/testdb'
>>> example_proxy.database_name
'testdb'

>>> example_proxy.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

>>> example_proxy.database_name
```

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`'postgres'`

Attributes

<code>DEFAULT_DATABASE</code>	Name of the database that is by default to connect with.
<code>DEFAULT_DIALECT</code>	Default dialect.
<code>DEFAULT_DRIVER</code>	Default name of database driver.
<code>DEFAULT_HOST</code>	Default host name/address (by installation of PostgreSQL).
<code>DEFAULT_PORT</code>	Default listening port used by PostgreSQL.
<code>DEFAULT_SCHEMA</code>	Name of the schema that is created by default for the installation of PostgreSQL.
<code>DEFAULT_USERNAME</code>	Default username.

PostgreSQL.DEFAULT_DATABASE

`PostgreSQL.DEFAULT_DATABASE = 'postgres'`

Name of the database that is by default to connect with. The database is created by installation of PostgreSQL.

PostgreSQL.DEFAULT_DIALECT

`PostgreSQL.DEFAULT_DIALECT = 'postgresql'`

Default dialect. The dialect that SQLAlchemy uses to communicate with PostgreSQL; see also [DBMS-PS-1]

PostgreSQL.DEFAULT_DRIVER

`PostgreSQL.DEFAULT_DRIVER = 'psycopg2'`

Default name of database driver.

PostgreSQL.DEFAULT_HOST

`PostgreSQL.DEFAULT_HOST = 'localhost'`

Default host name/address (by installation of PostgreSQL).

PostgreSQL.DEFAULT_PORT

```
PostgreSQL.DEFAULT_PORT = 5432
```

Default listening port used by PostgreSQL.

PostgreSQL.DEFAULT_SCHEMA

```
PostgreSQL.DEFAULT_SCHEMA = 'public'
```

Name of the schema that is created by default for the installation of PostgreSQL.

PostgreSQL.DEFAULT_USERNAME

```
PostgreSQL.DEFAULT_USERNAME = 'postgres'
```

Default username.

Methods

<code>add_primary_keys(primary_keys, table_name[, ...])</code>	Add a primary key or multiple primary keys to a table.
<code>alter_table_schema(table_name, schema_name, ...)</code>	Move a table from one schema to another within the currently-connected database.
<code>connect_database([database_name, verbose])</code>	Establish a connection to a database.
<code>create_database(database_name[, verbose])</code>	Create a database.
<code>create_schema(schema_name[, verbose])</code>	Create a schema.
<code>create_table(table_name, column_specs[, ...])</code>	Create a table.
<code>database_exists([database_name])</code>	Check whether a database exists.
<code>disconnect_all_others()</code>	Kill connections to all databases except the currently-connected one.
<code>disconnect_database([database_name, verbose])</code>	Disconnect a database.
<code>drop_database([database_name, ...])</code>	Delete/drop a database.
<code>drop_schema(schema_names[, ...])</code>	Delete/drop one or multiple schemas.
<code>drop_table(table_name[, schema_name, ...])</code>	Delete/drop a table.
<code>get_column_dtype(table_name[, column_names, ...])</code>	Get information about data types of all or specific columns of a table.
<code>get_column_info(table_name[, schema_name, ...])</code>	Get information about columns of a table.
<code>get_database_names([names_only])</code>	Get names of all existing databases.
<code>get_database_size([database_name])</code>	Get the size of a database.
<code>get_primary_keys(table_name[, schema_name, ...])</code>	Get the primary keys of a table.
<code>get_schema_names([include_all, names_only, ...])</code>	Get the names of existing schemas.
<code>get_table_names([schema_name, verbose])</code>	Get the names of all tables in a schema.
<code>import_data(data, table_name[, schema_name, ...])</code>	Import tabular data into a table.
<code>null_text_to_empty_string(table_name[, ...])</code>	Convert null values (in text columns) to empty strings.
<code>psql_insert_copy(sql_table, sql_db_engine, ...)</code>	A callable using PostgreSQL COPY clause for executing inserting data.
<code>read_sql_query(sql_query[, method, ...])</code>	Read table data by SQL query (recommended for large table).
<code>read_table(table_name[, schema_name, ...])</code>	Read data from a table.
<code>schema_exists(schema_name)</code>	Check whether a schema exists.
<code>table_exists(table_name[, schema_name])</code>	Check whether a table exists.

PostgreSQL.add_primary_keys

`PostgreSQL.add_primary_keys(primary_keys, table_name, schema_name=None)`

Add a primary key or multiple primary keys to a table.

Parameters

- **primary_keys** (*str or list or None*) – (list of) primary key(s)
- **table_name** (*str*) – name of a table
- **schema_name** (*str or None*) – name of a schema, defaults to None

See also:

- Examples for the method `pyhelpers.dbms.PostgreSQL.get_primary_keys()`.

PostgreSQL.alter_table_schema

`PostgreSQL.alter_table_schema(table_name, schema_name, new_schema_name, confirmation_required=True, verbose=False)`

Move a table from one schema to another within the currently-connected database.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str*) – name of a schema
- **new_schema_name** – name of a new schema
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to True
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to False

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> # Create a new table named "test_table" in the schema "testdb"
>>> new_tbl_name = 'test_table'
>>> col_spec = 'col_name_1 INT, col_name_2 TEXT'
>>> testdb.create_table(table_name=new_tbl_name, column_specs=col_spec, verbose=True)
Creating a table: "public"."test_table" ... Done.

>>> # Create a new schema "test_schema"
>>> testdb.create_schema(schema_name='test_schema', verbose=True)
Creating a schema: "test_schema" ... Done.
```

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```

>>> # Move the table "public"."test_table" to the schema "test_schema"
>>> testdb.alter_table_schema(
...     table_name='test_table', schema_name='public', new_schema_name='test_schema',
...     verbose=True)
To move the table "test_table" from the schema "public" to "test_schema"
? [No]|Yes: yes
Moving "public"."test_table" to "test_schema" ... Done.

>>> lst_tbl_names = testdb.get_table_names(schema_name='test_schema')
>>> lst_tbl_names
['test_table']

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

PostgreSQL.connect_database

PostgreSQL.**connect_database**(*database_name=None, verbose=False*)

Establish a connection to a database.

Parameters

- **database_name** (*str* or *None*) – name of a database; when `database_name=None` (default), the database name is input manually
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to `False`

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.connect_database(verbose=True)
Being connected with postgres:***@localhost:5432/testdb.

>>> testdb.connect_database(database_name='postgres', verbose=True)
Connecting postgres:***@localhost:5432/postgres ... Successfully.
>>> testdb.database_name
'postgres'

>>> testdb.connect_database(database_name='testdb', verbose=True)
Connecting postgres:***@localhost:5432/testdb ... Successfully.
>>> testdb.database_name
'testdb'

```

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```
>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
>>> testdb.database_name
'postgres'
```

PostgreSQL.create_database

PostgreSQL.create_database(database_name, verbose=False)

Create a database.

Parameters

- **database_name** (*str*) – name of a database
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to False

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.
>>> testdb.database_name
'testdb'

>>> testdb.create_database(database_name='testdb1', verbose=True)
Creating a database: "testdb1" ... Done.
>>> testdb.database_name
'testdb1'

>>> # Delete the database "testdb1"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb1" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb1" ... Done.
>>> testdb.database_name
'postgres'

>>> # Delete the database "testdb"
>>> testdb.drop_database(database_name='testdb', verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
>>> testdb.database_name
'postgres'
```

PostgreSQL.create_schema

PostgreSQL.create_schema(*schema_name*, *verbose=False*)

Create a schema.

Parameters

- **schema_name** (*str*) – name of a schema
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to False

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> test_schema_name = 'test_schema'

>>> testdb.create_schema(schema_name=test_schema_name, verbose=True)
Creating a schema: "test_schema" ... Done.

>>> testdb.schema_exists(schema_name=test_schema_name)
True

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.create_table

PostgreSQL.create_table(*table_name*, *column_specs*, *schema_name=None*, *verbose=False*)

Create a table.

Parameters

- **table_name** (*str*) – name of a table
- **column_specs** (*str*) – specifications for each column of the table
- **schema_name** (*str* or *None*) – name of a schema; when *schema_name=None* (default), it defaults to *DEFAULT_SCHEMA* (i.e. 'public')
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to False

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> tbl_name = 'test_table'
>>> col_spec = 'col_name_1 INT, col_name_2 TEXT'

>>> testdb.create_table(table_name=tbl_name, column_specs=col_spec, verbose=True)
Creating a table "public"."test_table" ... Done.

>>> testdb.table_exists(table_name=tbl_name)
True

>>> # Get information about all columns of the table "public"."test_table"
>>> test_tbl_col_info = testdb.get_column_info(table_name=tbl_name, as_dict=False)
>>> test_tbl_col_info

```

	column_0	column_1
table_catalog	testdb	testdb
table_schema	public	public
table_name	test_table	test_table
column_name	col_name_1	col_name_2
ordinal_position	1	2
column_default	None	None
is_nullable	YES	YES
data_type	integer	text
character_maximum_length	None	None
character_octet_length	NaN	1073741824.0
numeric_precision	32.0	NaN
numeric_precision_radix	2.0	NaN
numeric_scale	0.0	NaN
datetime_precision	None	None
interval_type	None	None
interval_precision	None	None
character_set_catalog	None	None
character_set_schema	None	None
character_set_name	None	None
collation_catalog	None	None
collation_schema	None	None
collation_name	None	None
domain_catalog	None	None
domain_schema	None	None
domain_name	None	None
udt_catalog	testdb	testdb
udt_schema	pg_catalog	pg_catalog
udt_name	int4	text
scope_catalog	None	None
scope_schema	None	None
scope_name	None	None
maximum_cardinality	None	None
dtd_identifier	1	2
is_self_referencing	NO	NO
is_identity	NO	NO
identity_generation	None	None
identity_start	None	None

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```

identity_increment      None      None
identity_maximum       None      None
identity_minimum       None      None
identity_cycle         NO        NO
is_generated           NEVER     NEVER
generation_expression   None      None
is_updatable           YES       YES

>>> # Get data types of all columns of the table "public"."test_table"
>>> test_tbl_dtypes = testdb.get_column_dtype(table_name=tbl_name)
>>> test_tbl_dtypes
{'col_name_1': 'integer', 'col_name_2': 'text'}

>>> # Drop the table "public"."test_table"
>>> testdb.drop_table(table_name=tbl_name, verbose=True)
To drop the table "public"."test_table" from postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Dropping "public"."test_table" ... Done.

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

PostgreSQL.database_exists

PostgreSQL.database_exists(*database_name=None*)

Check whether a database exists.

Parameters *database_name* (*str* or *None*) – name of a database, defaults to *None*

Returns whether the database exists

Return type *bool*

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> # Check whether the database "testdb" exists now
>>> testdb.database_exists(database_name='testdb') # testdb.database_exists()
True
>>> testdb.database_name
'testdb'

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)

```

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```

To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

>>> # Check again whether the database "testdb" still exists now
>>> testdb.database_exists(database_name='testdb')
False
>>> testdb.database_name
'postgres'

```

PostgreSQL.disconnect_all_others

PostgreSQL.disconnect_all_others()

Kill connections to all databases except the currently-connected one.

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.database_name
'testdb'

>>> testdb.disconnect_all_others()
>>> testdb.database_name
'testdb'

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

PostgreSQL.disconnect_database

PostgreSQL.disconnect_database(database_name=None, verbose=False)

Disconnect a database.

See also [DBMS-PS-DD-1].

Parameters

- **database_name** (*str* or *None*) – name of database to disconnect from; if database_name=None (default), disconnect the current database.
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to False

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Creating a database: "testdb" ... Done.
Password (postgres@localhost:5432): ***
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.database_name
'testdb'

>>> testdb.disconnect_database()
>>> testdb.database_name
'postgres'

>>> # Delete the database "testdb"
>>> testdb.drop_database(database_name='testdb', verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.drop_database

`PostgreSQL.drop_database(database_name=None, confirmation_required=True, verbose=False)`

Delete/drop a database.

Parameters

- **database_name** (*str* or *None*) – database to be disconnected; if `database_name=None` (default), drop the database being currently currentted
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to `True`
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to `False`

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Connecting postgres:***@localhost:5432/testdb ... Successfully.
>>> testdb.database_name
'testdb'

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

>>> testdb.database_exists(database_name='testdb')
False
```

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```
>>> testdb.drop_database(database_name='testdb', verbose=True)
The database "testdb" does not exist.
>>> testdb.database_name
'postgres'
```

PostgreSQL.drop_schema

PostgreSQL.drop_schema(schema_names, confirmation_required=True, verbose=False)

Delete/drop one or multiple schemas.

Parameters

- **schema_names** (*str* or *Iterable[str]*) – name of one schema, or names of multiple schemas
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to True
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to False

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> new_schema_names = ['points', 'lines', 'polygons']
>>> for new_schema in new_schema_names:
...     testdb.create_schema(new_schema, verbose=True)
Creating a schema: "points" ... Done.
Creating a schema: "lines" ... Done.
Creating a schema: "polygons" ... Done.

>>> new_schema_names_ = ['test_schema']
>>> testdb.drop_schema(new_schema_names + new_schema_names_, verbose=True)
To drop the following schemas from postgres:***@localhost:5432/testdb:
    "points"
    "lines"
    "polygons"
    "test_schema"
? [No] | Yes: yes
Dropping ...
    "points" ... Done.
    "lines" ... Done.
    "polygons" ... Done.
    "test_schema" (does not exist.)

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
```

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```
? [No] | Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.drop_table

`PostgreSQL.drop_table(table_name, schema_name=None, confirmation_required=True, verbose=False)`

Delete/drop a table.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str or None*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to `True`
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to `False`

See also:

- Examples for the method `pyhelpers.dbms.PostgreSQL.create_table()`.

PostgreSQL.get_column_dtype

`PostgreSQL.get_column_dtype(table_name, column_names=None, schema_name=None)`

Get information about data types of all or specific columns of a table.

Parameters

- **table_name** (*str*) – name of a table
- **column_names** (*str or list or None*) – (list of) column name(s); when `column_names=None` (default), all available columns are included
- **schema_name** – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')

Returns data types of all or specific columns of a table

Return type dict or None

See also:

- Examples for the method `pyhelpers.dbms.PostgreSQL.create_table()`.

PostgreSQL.get_column_info

PostgreSQL.get_column_info(*table_name*, *schema_name=None*, *as_dict=True*)

Get information about columns of a table.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str* or *None*) – name of a schema; when *schema_name=None* (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')
- **as_dict** (*bool*) – whether to return the column information as a dictionary, defaults to `True`

Returns information about all columns of the given table

Return type pandas.DataFrame or dict

See also:

- Examples for the method `pyhelpers.dbms.PostgreSQL.create_table()`.

PostgreSQL.get_database_names

PostgreSQL.get_database_names(*names_only=True*)

Get names of all existing databases.

Parameters *names_only* (*bool*) – whether to return only the names of the databases, defaults to `True`

Returns names of all existing databases

Return type list or pandas.DataFrame

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> # Connect the default database 'postgres'
>>> # postgres = PostgreSQL('localhost', 5432, 'postgres', database_name='postgres')
>>> postgres = PostgreSQL()
Password (postgres@localhost:5432): ***
Connecting postgres:***@localhost:5432/postgres ... Successfully.

>>> postgres.get_database_names()
['template1',
 'template0',
 'postgis_32_sample',
 'postgres']
```

PostgreSQL.get_database_size

PostgreSQL.get_database_size(*database_name=None*)

Get the size of a database.

Parameters *database_name* (*str* or *None*) – name of a database; if *database_name=None* (default), the function returns the size of the currently-connected database

Returns size of the database

Return type *int*

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.
>>> testdb.get_database_size()
'8553 kB'

>>> testdb.DEFAULT_DATABASE
'postgres'
>>> testdb.get_database_size(database_name=testdb.DEFAULT_DATABASE)
'8609 kB'

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.get_primary_keys

PostgreSQL.get_primary_keys(*table_name*, *schema_name=None*, *names_only=True*)

Get the primary keys of a table.

Parameters

- *table_name* (*str*) – name of a table
- *schema_name* (*str* or *None*) – name of a schema, defaults to *None*
- *names_only* (*bool*) – whether to return only the names of the primary keys, defaults to *True*

Returns primary key(s) of the given table

Return type *list* or *pandas.DataFrame*

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL
>>> from pyhelpers._cache import example_dataframe

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> dat = example_dataframe()
>>> dat
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> tbl_name = 'test_table'

>>> testdb.import_data(data=dat, table_name=tbl_name, index=True, verbose=True)
To import data into "public"."test_table" at postgres:***@localhost:5432/postgres
? [No] | Yes: yes

>>> pri_keys = testdb.get_primary_keys(table_name=tbl_name)
>>> pri_keys
[]

>>> testdb.add_primary_keys(primary_keys='City', table_name=tbl_name)

```

The “test_table” is illustrated in Fig. 14 below:

	City [PK] text	Longitude double precision	Latitude double precision
1	Birmingham	-1.9026911	52.4796992
2	Leeds	-1.5437941	53.7974185
3	London	-0.1276474	51.5073219
4	Manchester	-2.2451148	53.4794892

Fig. 14: The table “test_table” (with a primary key) in the database.

```

>>> pri_keys = testdb.get_primary_keys(table_name=tbl_name)
>>> pri_keys
['City']
>>> pri_keys = testdb.get_primary_keys(table_name=tbl_name, names_only=False)
>>> pri_keys
  key_column  data_type
0      City      text

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432

```

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```
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.get_schema_names

PostgreSQL.get_schema_names(include_all=False, names_only=True, verbose=False)

Get the names of existing schemas.

Parameters

- **include_all** (*bool*) – whether to list all the available schemas, defaults to False
- **names_only** (*bool*) – whether to return only the names of the schema names, defaults to True
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to False

Returns schema names

Return type list or pandas.DataFrame or None

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.get_schema_names()
['public']

>>> testdb.get_schema_names(include_all=True, names_only=False)
   schema_name  schema_id  role
0  information_schema    13388  postgres
1         pg_catalog         11  postgres
2         pg_toast         99  postgres
3          public        2200  postgres

>>> testdb.drop_schema(schema_names='public', verbose=True)
To drop the schema "public" from postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Dropping "public" ... Done.

>>> testdb.get_schema_names() # None

>>> testdb.get_schema_names(verbose=True)
No schema exists in the currently-connected database "testdb".

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
```

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```
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.get_table_names

PostgreSQL.get_table_names(*schema_name=None, verbose=False*)

Get the names of all tables in a schema.

Parameters

- **schema_name** (*str or None*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to `False`

Returns a list of table names

Return type list or None

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> lst_tbl_names = testdb.get_table_names()
>>> lst_tbl_names
[]

>>> lst_tbl_names = testdb.get_table_names(schema_name='testdb', verbose=True)
The schema "testdb" does not exist.

>>> # Create a new table named "test_table" in the schema "testdb"
>>> new_tbl_name = 'test_table'
>>> col_spec = 'col_name_1 INT, col_name_2 TEXT'
>>> testdb.create_table(table_name=new_tbl_name, column_specs=col_spec, verbose=True)
Creating a table: "public"."test_table" ... Done.

>>> lst_tbl_names = testdb.get_table_names(schema_name='public')
>>> lst_tbl_names
['test_table']

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.import_data

```
PostgreSQL.import_data(data, table_name, schema_name=None, if_exists='fail',
                       force_replace=False, chunk_size=None, col_type=None, method='multi',
                       index=False, confirmation_required=True, verbose=False, **kwargs)
```

Import tabular data into a table.

See also [DBMS-PS-ID-1] and [DBMS-PS-ID-2].

Parameters

- **data** (*pandas.DataFrame* or *pandas.io.parsers.TextFileReader* or *list* or *tuple*) – tabular data to be dumped into a database
- **table_name** (*str*) – name of a table
- **schema_name** (*str*) – name of a schema; when *schema_name=None* (default), it defaults to *DEFAULT_SCHEMA* (i.e. 'public')
- **if_exists** (*str*) – if the table already exists, to 'replace', 'append' or, by default, 'fail' and do nothing but raise a *ValueError*.
- **force_replace** (*bool*) – whether to force replacing existing table, defaults to *False*
- **chunk_size** (*int* or *None*) – the number of rows in each batch to be written at a time, defaults to *None*
- **col_type** (*dict* or *None*) – data types for columns, defaults to *None*
- **method** (*str* or *None* or *Callable*) – method for SQL insertion clause, defaults to 'multi'
 - *None*: uses standard SQL INSERT clause (one per row);
 - 'multi': pass multiple values in a single INSERT clause;
 - callable (e.g. *PostgreSQL.psycopg_insert_copy*) with signature (*pd_table*, *conn*, *keys*, *data_iter*).
- **index** (*bool*) – whether to dump the index as a column
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to *True*
- **verbose** (*bool* or *int*) – whether to print relevant information in console as the function runs, defaults to *False*
- **kwargs** – [optional] parameters of *pandas.DataFrame.to_sql*

See also:

- Examples for the method *pyhelpers.dbms.PostgreSQL.read_sql_query()*.

PostgreSQL.null_text_to_empty_string

PostgreSQL.null_text_to_empty_string(*table_name*, *column_names=None*,
schema_name=None)

Convert null values (in text columns) to empty strings.

Parameters

- **table_name** (*str*) – name of a table
- **column_names** (*str or list or None*) – (list of) column name(s); when *column_names=None* (default), all available columns are included
- **schema_name** (*str*) – name of a schema

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL
>>> from pyhelpers._cache import example_dataframe

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> dat = example_dataframe()
>>> dat.Longitude = dat.Longitude.astype(str)
>>> dat.loc['London', 'Longitude'] = None
>>> dat
```

	Longitude	Latitude
City		
London	None	51.507322
Birmingham	-1.9026911	52.479699
Manchester	-2.2451148	53.479489
Leeds	-1.5437941	53.797418

```
>>> tbl_name = 'test_table'

>>> testdb.import_data(data=dat, table_name=tbl_name, index=True, verbose=True)
To import data into "public"."test_table" at postgres:***@localhost:5432/postgres
? [No]|Yes: yes

>>> testdb.table_exists(table_name=tbl_name)
True

>>> testdb.get_column_dtype(table_name=tbl_name)
{'City': 'text', 'Longitude': 'text', 'Latitude': 'double precision'}
```

	City text	Longitude text	Latitude double precision
1	London	[null]	51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 15: The table “test_table” in the database “testdb”.

```
>>> # Replace the 'null' value with an empty string
>>> testdb.null_text_to_empty_string(table_name=tbl_name)
```

	City text	Longitude text	Latitude double precision
1	London		51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 16: The table “test_table” in the database “testdb” (after converting ‘null’ to empty string).

```
>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No] | Yes: yes
Dropping "testdb" ... Done.
```

PostgreSQL.psql_insert_copy

static PostgreSQL.psql_insert_copy(sql_table, sql_db_engine, column_names, data_iter)

A callable using PostgreSQL COPY clause for executing inserting data.

Parameters

- **sql_table** – pandas.io.sql.SQLTable
- **sql_db_engine** – sqlalchemy.engine.Connection or sqlalchemy.engine.Engine
- **column_names** – (list of str) column names
- **data_iter** – iterable that iterates the values to be inserted

Note: This function is copied and slightly modified from the source code available at [\[DBMS-PS-PIC-1\]](#).

PostgreSQL.read_sql_query

`PostgreSQL.read_sql_query(sql_query, method='tempfile', max_size_spooled=1, delimiter=',',
tempfile_kwargs=None, stringio_kwargs=None, **kwargs)`

Read table data by SQL query (recommended for large table).

See also [\[DBMS-PS-RSQ-1\]](#), [\[DBMS-PS-RSQ-2\]](#) and [\[DBMS-PS-RSQ-3\]](#).

Parameters

- `sql_query` (*str*) – a SQL query to be executed
- `method` (*str*) – method to be used for buffering temporary data
 - 'tempfile' (default): use `tempfile.TemporaryFile`
 - 'stringio': use `io.StringIO`
 - 'spooled': use `tempfile.SpooledTemporaryFile`
- `max_size_spooled` (*int* or *float*) – max_size of `tempfile.SpooledTemporaryFile`, defaults to 1 (in gigabyte)
- `delimiter` (*str*) – delimiter used in data, defaults to ','
- `tempfile_kwargs` (*dict* or *None*) – [optional] parameters of `tempfile.TemporaryFile` or `tempfile.SpooledTemporaryFile`
- `stringio_kwargs` (*dict* or *None*) – [optional] parameters of `io.StringIO`, e.g. `initial_value` (default: '')
- `kwargs` – [optional] parameters of `pandas.read_csv`

Returns data frame as queried by the statement `sql_query`

Return type `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL
>>> from pyhelpers._cache import example_dataframe

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> # Create an example dataframe
>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
```

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```

City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> table = 'England'
>>> schema = 'points'

>>> # Import the data into a table named "points"."England"
>>> testdb.import_data(example_df, table, schema, index=True, verbose=2)
To import data into "points"."England" at postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Creating a schema: "points" ... Done.
Importing the data into the table "points"."England" ... Done.

```

The table *"points"."England"* is illustrated in Fig. 14 below:

The screenshot shows a database management interface. On the left, a tree view displays the database structure. The 'testdb' database is expanded, showing various objects. Under the 'Schemas (2)' section, the 'points' schema is expanded, and the 'England' table is selected. The main panel on the right shows the 'Query Editor' with a query: `SELECT * FROM points."England"`. Below the query editor, the 'Data Output' tab is active, displaying the results of the query in a table format.

	City	Longitude	Latitude
	text	double precision	double precision
1	London	-0.1276474	51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 17: The table *"points"."England"* in the database *"testdb"*.

```

>>> rslt = testdb.table_exists(table_name=table, schema_name=schema)
>>> print(f"The table \"{schema}\".\"{table}\" exists? {rslt}.")
The table "points"."England" exists? True.

>>> # Retrieve the data using the method .read_table()
>>> example_df_ret = testdb.read_table(table, schema_name=schema, index_col='City')
>>> example_df_ret
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> # Alternatively, read the data by a SQL query statement
>>> sql_qry = f'SELECT * FROM \"{schema}\".\"{table}\"'
>>> example_df_ret_alt = testdb.read_sql_query(sql_query=sql_qry, index_col='City')
>>> example_df_ret_alt
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> example_df_ret.equals(example_df_ret_alt)
True

>>> # Delete the table "points"."England"
>>> testdb.drop_table(table_name=table, schema_name=schema, verbose=True)
To drop the table "points"."England" from postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Dropping "points"."England" ... Done.

>>> # Delete the schema "points"
>>> testdb.drop_schema(schema_names=schema, verbose=True)
To drop the schema "points" from postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Dropping "points" ... Done.

>>> # Delete the database "testdb"
>>> testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

Aside: a brief example of using the parameter params for `pandas.read_sql`

```

import datetime
import pandas as pd

sql_qry = 'SELECT * FROM "table_name" '
        'WHERE "timestamp_column_name" BETWEEN %(ts_start)s AND %(ts_end)s'

params = {'d_start': datetime.datetime.today(), 'd_end': datetime.datetime.today()}

data_frame = pd.read_sql(sql=sql_qry, con=testdb.engine, params=params)

```


PostgreSQL.read_table

`PostgreSQL.read_table(table_name, schema_name=None, conditions=None, chunk_size=None, sorted_by=None, **kwargs)`

Read data from a table.

See also [DBMS-PS-RT-1].

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')
- **conditions** (*str or None*) – defaults to `None`
- **chunk_size** (*int or None*) – number of rows to include in each chunk, defaults to `None`
- **sorted_by** (*str or None*) – name(s) of a column (or columns) by which the retrieved data is sorted, defaults to `None`
- **kwargs** – [optional] parameters of the method `read_sql_query()` or the function `pandas.read_sql()`

Returns data frame from the specified table

Return type `pandas.DataFrame`

See also:

- Examples for the method `pyhelpers.dbms.PostgreSQL.read_sql_query()`.

PostgreSQL.schema_exists

`PostgreSQL.schema_exists(schema_name)`

Check whether a schema exists.

Parameters **schema_name** (*str*) – name of a schema

Returns whether the schema exists

Return type `bool`

Examples:

```
>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> testdb.schema_exists('public')
```

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```

True

>>> testdb.schema_exists('test_schema') # (if the schema 'test_schema' does not exist)
False

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

PostgreSQL.table_exists

PostgreSQL.**table_exists**(*table_name*, *schema_name=None*)

Check whether a table exists.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str*) – name of a schema; when *schema_name=None* (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')

Returns whether the table exists in the currently-connected database

Return type bool

Examples:

```

>>> from pyhelpers.dbms import PostgreSQL

>>> testdb = PostgreSQL('localhost', 5432, 'postgres', database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> tbl_name = 'points'

>>> testdb.table_exists(table_name=tbl_name) # (if 'public.points' does not exist)
False

>>> testdb.create_table(table_name=tbl_name, column_specs='column_0 INT', verbose=1)
Creating a table: "public"."points" ... Done.
>>> testdb.table_exists(table_name=tbl_name)
True

>>> testdb.drop_table(table_name=tbl_name, verbose=True)
To drop the table "public"."points" from postgres:***@localhost:5432/testdb
? [No]|Yes: yes
Dropping "public"."points" ... Done.

>>> testdb.drop_database(verbose=True) # Delete the database "testdb"
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.

```

MSSQL

```
class pyhelpers.dbms.MSSQL(host=None, port=None, username=None, password=None,  
                           database_name=None, confirm_db_creation=False, verbose=True)
```

A class for basic communication with [Microsoft SQL Server](#) databases.

Parameters

- **host** (*str* or *None*) – name of the server running the SQL Server, e.g. 'localhost' or '127.0.0.1'; when host=None (default), it is initialized as 'localhost'
- **port** (*int* or *None*) – listening port; when port=None (default), it is initialized as 1433 (default by installation of the SQL Server)
- **username** (*str* or *None*) – name of the user or login used to connect; when username=None (default), the instantiation relies on Windows Authentication
- **password** (*str* or *int* or *None*) – user's password; when password=None (default), it is required to manually type in the correct password to connect the PostgreSQL server
- **database_name** (*str* or *None*) – name of a database; when database=None (default), it is initialized as 'master'
- **confirm_db_creation** (*bool*) – whether to prompt a confirmation before creating a new database (if the specified database does not exist), defaults to False
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to True

Variables

- **host** (*str*) – host name/address
- **port** (*str*) – listening port used by PostgreSQL
- **username** (*str*) – username
- **database_name** (*str*) – name of a database
- **credentials** (*dict*) – basic information about the server/database being connected
- **auth** (*str* or *None*) – authentication method (used for establish the connection)
- **address** (*str*) – representation of the database address
- **engine** (*sqlalchemy.engine.Engine*) – a [SQLAlchemy](#) connectable engine to a SQL Server; see also [\[DBMS-MS-3\]](#)

Examples:

```

>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.address
'<server_name>@localhost:1433/master'

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> testdb.database_name
'testdb'

>>> testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

```

Attributes

<i>DEFAULT_DATABASE</i>	Default database name.
<i>DEFAULT_DIALECT</i>	Default dialect.
<i>DEFAULT_DRIVER</i>	Default name of database driver.
<i>DEFAULT_HOST</i>	Default host (server name).
<i>DEFAULT_ODBC_DRIVER</i>	Default ODBC driver.
<i>DEFAULT_PORT</i>	Default listening port used by Microsoft SQL Server.
<i>DEFAULT_SCHEMA</i>	Default schema name.
<i>DEFAULT_USERNAME</i>	Default username.

MSSQL.DEFAULT_DATABASE

`MSSQL.DEFAULT_DATABASE = 'master'`

Default database name.

MSSQL.DEFAULT_DIALECT

`MSSQL.DEFAULT_DIALECT = 'mssql'`

Default dialect. The dialect that SQLAlchemy uses to communicate with Microsoft SQL Server; see also [\[DBMS-MS-1\]](#).

MSSQL.DEFAULT_DRIVER

```
MSSQL.DEFAULT_DRIVER = 'pyodbc'
```

Default name of database driver. See also [\[DBMS-MS-2\]](#).

MSSQL.DEFAULT_HOST

```
MSSQL.DEFAULT_HOST = 'localhost'
```

Default host (server name). Alternatively, `os.environ['COMPUTERNAME']`

MSSQL.DEFAULT_ODBC_DRIVER

```
MSSQL.DEFAULT_ODBC_DRIVER = 'ODBC Driver 17 for SQL Server'
```

Default ODBC driver.

MSSQL.DEFAULT_PORT

```
MSSQL.DEFAULT_PORT = 1433
```

Default listening port used by Microsoft SQL Server.

MSSQL.DEFAULT_SCHEMA

```
MSSQL.DEFAULT_SCHEMA = 'dbo'
```

Default schema name.

MSSQL.DEFAULT_USERNAME

```
MSSQL.DEFAULT_USERNAME = 'sa'
```

Default username.

Methods

<code>connect_database</code> ([database_name, verbose])	Establish a connection to a database.
<code>create_connection</code> ([database_name, ...])	Create a SQLAlchemy connection.
<code>create_cursor</code> ([database_name])	Create a <code>pyodbc</code> cursor.
<code>create_database</code> (database_name[, verbose])	Create a database.
<code>create_engine</code> ([database_name, auth, password])	Create a <code>SQLAlchemy</code> connectable engine.
<code>create_schema</code> (schema_name[, verbose])	Create a schema.
<code>create_table</code> (table_name, column_specs[, ...])	Create a table.
<code>database_exists</code> ([database_name])	Check whether a database exists.
<code>disconnect_database</code> ([database_name, verbose])	Disconnect a database.
<code>drop_database</code> ([database_name, ...])	Delete/drop a database.
<code>drop_table</code> (table_name[, schema_name, ...])	Delete/drop a table.
<code>get_column_names</code> (table_name[, schema_name])	Get column names of a table.
<code>get_database_names</code> ([names_only])	Get names of all existing databases.
<code>get_file_tables</code> ([names_only])	Get information about <code>FileTables</code> (if available).
<code>get_primary_keys</code> ([table_name, schema_name, ...])	Get the primary keys of table(s).
<code>get_row_count</code> (table_name[, schema_name])	Get row count of a table in a database.
<code>get_table_names</code> ([schema_name])	Get names of all tables stored in a schema.
<code>has_dtypes</code> (table_name, dtypes[, schema_name])	Check whether a table contains data of a certain data type or data types.
<code>import_data</code> (data, table_name[, schema_name, ...])	Import tabular data into a table.
<code>read_columns</code> (table_name, column_names[, ...])	Read data of specific columns of a table.
<code>read_table</code> (table_name[, schema_name, ...])	Read data from a table.
<code>schema_exists</code> (schema_name)	Check whether a schema exists.
<code>specify_conn_str</code> ([database_name, auth, password])	Specify a string used for establishing a connection.
<code>table_exists</code> (table_name[, schema_name])	Check whether a table exists.

MSSQL.connect_database

`MSSQL.connect_database(database_name=None, verbose=False)`

Establish a connection to a database.

Parameters

- **database_name** (*str* or *None*) – name of a database; when `database_name=None` (default), the database name is input manually
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> testdb.connect_database(verbose=True)
Being connected with <server_name>@localhost:1433/testdb.

>>> testdb.connect_database(database_name='master', verbose=True)
Connecting <server_name>@localhost:1433/master ... Successfully.
>>> testdb.database_name
'master'

>>> testdb.connect_database(database_name='testdb', verbose=True)
Connecting <server_name>@localhost:1433/testdb ... Successfully.
>>> testdb.database_name
'testdb'

>>> testdb.drop_database(verbose=True) # Delete the database [testdb]
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.
>>> testdb.database_name
'master'
```

MSSQL.create_connection

`MSSQL.create_connection(database_name=None, close_with_result=False, mode=None)`

Create a SQLAlchemy connection.

Parameters

- **database_name** (*str* or *None*) – name of a database, defaults to the name of the currently-connected database when `database=None`
- **close_with_result** (*bool*) – parameter of the method `sqlalchemy.engine.Engine.connect()`, defaults to `False`

- **mode** (*None* or *str*) – when mode=None (default), the method uses the existing engine; when mode='pyodbc' (optional), it uses `pyodbc.connect()`

Returns a SQLAlchemy connection to a Microsoft SQL Server

Return type sqlalchemy.engine.Connection or pyodbc.Connection

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> db_conn = mssql.create_connection()
>>> db_conn.should_close_with_result
False
>>> db_conn.closed
False
>>> rslt = db_conn.execute('SELECT 1')
>>> rslt.fetchall()
[(1,)]
>>> db_conn.closed
False
>>> db_conn.close()
>>> db_conn.closed
True

>>> db_conn = mssql.create_connection(close_with_result=True)
>>> db_conn.should_close_with_result
True
>>> db_conn.closed
False
>>> rslt = db_conn.execute('SELECT 1')
>>> rslt.fetchall()
[(1,)]
>>> db_conn.closed
True
```

MSSQL.create_cursor

MSSQL.create_cursor(*database_name=None*)

Create a `pyodbc` cursor.

Parameters **database_name** (*str* or *None*) – name of a database, defaults to the name of the currently-connected database when database=None

Returns a `pyodbc` cursor

Return type pyodbc.Cursor

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
```

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```

Connecting <server_name>@localhost:1433/master ... Successfully.

>>> db_cur = mssql.create_cursor()

>>> # Get information about all tables in the database [master]
>>> tables_in_db = db_cur.tables(schema='dbo', tableType='TABLE')
>>> list(tables_in_db)
[('master', 'dbo', 'MSreplication_options', 'TABLE', None),
 ('master', 'dbo', 'spt_fallback_db', 'TABLE', None),
 ('master', 'dbo', 'spt_fallback_dev', 'TABLE', None),
 ('master', 'dbo', 'spt_fallback_usg', 'TABLE', None),
 ('master', 'dbo', 'spt_monitor', 'TABLE', None)]

>>> db_cur.close()

```

MSSQL.create_database

`MSSQL.create_database(database_name, verbose=False)`

Create a database.

Parameters

- **database_name** (*str*) – name of a database
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```

>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> testdb.database_name
'testdb'

>>> testdb.create_database(database_name='testdb1', verbose=True)
Creating a database: [testdb1] ... Done.
>>> testdb.database_name
'testdb1'

>>> # Delete the database [testdb1]
>>> testdb.drop_database(verbose=True)
To drop the database [testdb1] from <server_name>@localhost:5432
? [No]|Yes: yes
Dropping [testdb1] ... Done.
>>> testdb.database_name
'master'

>>> # Delete the database [testdb]
>>> testdb.drop_database(database_name='testdb', verbose=True)
To drop the database [testdb] from <server_name>@localhost:5432

```

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```
? [No] | Yes: yes
Dropping [testdb] ... Done.
>>> testdb.database_name
'master'
```

MSSQL.create_engine

`MSSQL.create_engine(database_name=None, auth=None, password=None)`

Create a [SQLAlchemy](#) connectable engine.

Connect string format: `'mssql+pyodbc://<username>:<password>@<dsn_name>'`

Parameters

- **database_name** (*str* or *None*) – name of a database, defaults to the name of the currently-connected database when database=None
- **auth** (*str* or *None*) – authentication method (used for establish the connection), defaults to the current authentication method when auth=None
- **password** (*str* or *int* or *None*) – user's password; when password=None (default), it is required to manually type in the correct password to connect the PostgreSQL server

Returns a SQLAlchemy connectable engine

Return type sqlalchemy.engine.Engine

1. Use [pyodbc](#) (or [pypyodbc](#)):

```
connect_string = 'driver={...};server=...;database=...;uid=username;pwd=...'
conn = pyodbc.connect(connect_string) # conn = pypyodbc.connect(connect_string)
```

2. Use [SQLAlchemy](#):

```
conn_string = 'mssql+pyodbc:///odbc_connect=%s' % quote_plus(connect_string)
engine = sqlalchemy.create_engine(conn_string)
conn = engine.connect()
```

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> db_engine = mssql.create_engine()
>>> db_engine.name
'mssql'

>>> db_engine.dispose()
```

MSSQL.create_schema

`MSSQL.create_schema(schema_name, verbose=False)`

Create a schema.

Parameters

- **schema_name** (*str*) – name of a schema in the currently-connected database
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> test_schema_name = 'test_schema'

>>> testdb.create_schema(schema_name=test_schema_name, verbose=True)
Creating a schema: [test_schema] ... Done.

>>> testdb.schema_exists(schema_name=test_schema_name)
True

>>> testdb.drop_database(verbose=True) # Delete the database [testdb]
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.
```

MSSQL.create_table

`MSSQL.create_table(table_name, column_specs, schema_name=None, verbose=False)`

Create a table.

Parameters

- **table_name** (*str*) – name of a table
- **column_specs** (*str*) – specifications for each column of the table
- **schema_name** (*str* or *None*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'dbo')
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
```

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```

Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> tbl_name = 'test_table'
>>> col_spec = 'col_name_1 INT, col_name_2 varchar(255)'

>>> testdb.create_table(table_name=tbl_name, column_specs=col_spec, verbose=True)
Creating a table: [dbo].[test_table] ... Done.

>>> testdb.table_exists(table_name=tbl_name)
True

>>> testdb.get_column_names(table_name=tbl_name)
['col_name_1', 'col_name_2']

>>> # Drop the table [dbo].[test_table]
>>> testdb.drop_table(table_name=tbl_name, verbose=True)
To drop the table [dbo].[test_table] from <server_name>@localhost:1433/testdb
? [No]|Yes: yes
Dropping [dbo].[test_table] ... Done.

>>> # Delete the database [testdb]
>>> testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

```

MSSQL.database_exists

MSSQL.database_exists(*database_name=None*)

Check whether a database exists.

Parameters *database_name* (*str* or *None*) – name of a database, defaults to *None*

Returns whether the database exists

Return type bool

Examples:

```

>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> # Check whether the database [testdb] exists now
>>> testdb.database_name
'testdb'
>>> testdb.database_exists(database_name='testdb')
True

>>> # Delete the database [testdb]

```

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```

>>> testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

>>> # Check again whether the database [testdb] still exists now
>>> testdb.database_exists(database_name='testdb')
False
>>> testdb.database_name
'master'

```

MSSQL.disconnect_database

`MSSQL.disconnect_database(database_name=None, verbose=False)`

Disconnect a database.

Parameters

- **database_name** (*str* or *None*) – name of database to disconnect from; if `database_name=None` (default), disconnect the current database.
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```

>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> testdb.database_name
'testdb'

>>> testdb.disconnect_database()
>>> testdb.database_name
'master'

>>> # Delete the database [testdb]
>>> testdb.drop_database(database_name='testdb', verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

>>> testdb.drop_database(database_name='testdb', verbose=True)
The database [testdb] does not exist.

```

MSSQL.drop_database

`MSSQL.drop_database(database_name=None, confirmation_required=True, verbose=False)`

Delete/drop a database.

Parameters

- **database_name** (*str* or *None*) – database to be disconnected; if `database_name=None` (default), drop the database being currently currentted
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to `True`
- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to `False`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.
>>> testdb.database_name
'testdb'

>>> testdb.drop_database(verbose=True) # Delete the database [testdb]
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

>>> testdb.database_exists(database_name='testdb')
False
>>> testdb.drop_database(database_name='testdb', verbose=True)
The database [testdb] does not exist.
>>> testdb.database_name
'master'
```

MSSQL.drop_table

`MSSQL.drop_table(table_name, schema_name=None, confirmation_required=True, verbose=False)`

Delete/drop a table.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str* or *None*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'dbo')
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to `True`

- **verbose** (*bool* or *int*) – whether to print relevant information in console, defaults to False

See also:

- Examples for the method `pyhelpers.dbms.MSSQL.create_table()`.

MSSQL.get_column_names

`MSSQL.get_column_names(table_name, schema_name=None)`

Get column names of a table.

Parameters

- **table_name** (*str*) – name of a table in the currently-connected database
- **schema_name** (*str* or *None*) – defaults to None

Returns a list of column names

Return type list

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.get_column_names(table_name='MSreplication_options')
['optname',
 'value',
 'major_version',
 'minor_version',
 'revision',
 'install_failures']
```

MSSQL.get_database_names

`MSSQL.get_database_names(names_only=True)`

Get names of all existing databases.

Parameters **names_only** (*bool*) – whether to return only the names of the databases, defaults to True

Returns names of all existing databases

Return type list or pandas.DataFrame

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_database_names()
['master',
 'tempdb',
 'model',
 'msdb']
```

MSSQL.get_file_tables

`MSSQL.get_file_tables(names_only=True)`

Get information about *FileTables* (if available).

Parameters `names_only` (*bool*) – whether to return *FileTables* names only, defaults to `True`

Returns information about *FileTables* (if available)

Return type list or `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_file_tables()
[]
```

MSSQL.get_primary_keys

`MSSQL.get_primary_keys(table_name=None, schema_name=None, table_type='TABLE')`

Get the primary keys of table(s).

Parameters

- **table_name** (*str* or *None*) – name of a table in the currently-connected database; when `table_name=None` (default), get the primary keys of all existing tables
- **schema_name** (*str* or *None*) – name of a schema, defaults to `DEFAULT_SCHEMA` when `schema_name=None`
- **table_type** (*str*) – table type, defaults to `'TABLE'`

Returns a list of primary keys

Return type list

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_primary_keys()
{}
```

MSSQL.get_row_count

`MSSQL.get_row_count(table_name, schema_name=None)`

Get row count of a table in a database.

Parameters

- **table_name** (*str*) – name of a table in the currently-connected database
- **schema_name** (*str or None*) – schema name of the given table, defaults to `None`

Returns count of rows in the given table

Return type `int`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.get_row_count(table_name='MSreplication_options')
3
```

MSSQL.get_table_names

`MSSQL.get_table_names(schema_name=None)`

Get names of all tables stored in a schema.

Parameters **schema_name** (*str or list or None*) – name of a schema, defaults to `DEFAULT_SCHEMA` when `schema_name=None`

Returns names of tables in the given schema `mssql_schema_name`

Return type `list`

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.get_table_names(schema_name=['dbo', 'sys'])
```

MSSQL.has_dtypes

`MSSQL.has_dtypes(table_name, dtypes, schema_name=None)`

Check whether a table contains data of a certain data type or data types.

Parameters

- **table_name** (*str*) – name of a table in the currently-connected database
- **dtypes** (*str* or *Sequence[str]*) – data types, such as 'geometry', 'hierarchyid', 'varbinary'
- **schema_name** (*str* or *None*) – name of a schema, defaults to `DEFAULT_SCHEMA` when `schema_name=None`

Returns data type, whether the table has this data type and the corresponding column names

Return type *Generator[str, bool, list]*

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> rslt = mssql.has_dtypes(table_name='spt_monitor', dtypes='varbinary')
>>> list(rslt)
[('varbinary', False, [])]

>>> rslt = mssql.has_dtypes(table_name='spt_monitor', dtypes=['geometry', 'int'])
>>> list(rslt)
```

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```
[('geometry', False, []),
 ('int',
  True,
  ['cpu_busy',
   'io_busy',
   'idle',
   'pack_received',
   'pack_sent',
   'connections',
   'pack_errors',
   'total_read',
   'total_write',
   'total_errors'])]
```

MSSQL.import_data

`MSSQL.import_data(data, table_name, schema_name=None, if_exists='fail', force_replace=False, chunk_size=None, col_type=None, method='multi', index=False, confirmation_required=True, verbose=False, **kwargs)`

Import tabular data into a table.

See also [\[DBMS-MS-ID-1\]](#).

Parameters

- **data** (*pandas.DataFrame* or *pandas.io.parsers.TextFileReader* or *list* or *tuple*) – tabular data to be dumped into a database
- **table_name** (*str*) – name of a table
- **schema_name** (*str* or *None*) – name of a schema; when `schema_name=None` (default), it defaults to `DEFAULT_SCHEMA` (i.e. 'public')
- **if_exists** (*str*) – if the table already exists, to 'replace', 'append' or, by default, 'fail' and do nothing but raise a `ValueError`.
- **force_replace** (*bool*) – whether to force replacing existing table, defaults to `False`
- **chunk_size** (*int* or *None*) – the number of rows in each batch to be written at a time, defaults to `None`
- **col_type** (*dict* or *None*) – data types for columns, defaults to `None`
- **method** (*str* or *None* or *Callable*) – method for SQL insertion clause, defaults to 'multi'
 - `None`: uses standard SQL INSERT clause (one per row);
 - 'multi': pass multiple values in a single INSERT clause;
 - callable (e.g. `PostgreSQL.psql_insert_copy`) with signature `(pd_table, conn, keys, data_iter)`.

- **index** (*bool*) – whether to dump the index as a column
- **confirmation_required** (*bool*) – whether to prompt a message for confirmation to proceed, defaults to True
- **verbose** (*bool or int*) – whether to print relevant information in console, defaults to False
- **kwargs** – [optional] parameters of `pandas.DataFrame.to_sql`

Examples:

```
>>> from pyhelpers.dbms import MSSQL
>>> from pyhelpers._cache import example_dataframe

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> test_table_name = 'example_df'

>>> testdb.import_data(example_df, table_name=test_table_name, index=True, verbose=2)
To import data into [dbo].[example_df] at <server_name>@localhost:1433/testdb
? [No]|Yes: yes
Importing the data into the table [dbo].[example_df] ... Done.
```

The imported example data can also be viewed using Microsoft SQL Server Management Studio (as illustrated in [Fig. 18](#) below):

The screenshot shows the SQL Server Enterprise Manager interface. On the left, the 'testdb' database is expanded, showing its structure: Database Diagrams, Tables, System Tables, FileTables, External Tables, Graph Tables, and the 'dbo.example_df' table. The 'dbo.example_df' table is expanded, showing its columns: City (varchar(max), null), Longitude (float, null), and Latitude (float, null). On the right, the 'Results' pane shows the data of the 'dbo.example_df' table. The table has four rows of data:

	City	Longitude	Latitude
1	London	-0.1276474	51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 18: The table `[dbo].[example_df]` in the database `[testdb]`.

```
>>> # Drop/delete the table [dbo].[example_df]
>>> testdb.drop_table(table_name=test_table_name, verbose=True)
To drop the table [dbo].[example_df] from <server_name>@localhost:1433/testdb
? [No]|Yes: yes
Dropping [dbo].[example_df] ... Done.

>>> # Drop/delete the database [testdb]
>>> testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.
```

See also:

- Examples for the method `pyhelpers.dbms.MSSQL.read_table()`.

MSSQL.read_columns

`MSSQL.read_columns(table_name, column_names, dtype=None, schema_name=None, chunk_size=None, **kwargs)`

Read data of specific columns of a table.

Parameters

- **table_name** (*str*) – name of a table in the currently-connected database

- **column_names** (*list or tuple*) – column name(s) of the specified table
- **dtype** (*str or None*) – data type, defaults to *None*; options include 'hierarchyid', 'varbinary' and 'geometry'
- **schema_name** (*str or None*) – name of a schema, defaults to *DEFAULT_SCHEMA* when *schema_name=None*
- **chunk_size** (*int or None*) – number of rows to include in each chunk (if specified), defaults to *None*
- **kwargs** – [optional] parameters of `pandas.read_sql`

Returns data of specific columns of the queried table

Return type `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.dbms import MSSQL
>>> from pyhelpers._cache import example_dataframe

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.read_columns('MSreplication_options', column_names=['optname', 'value'])
  optname  value
0  transactional  True
1         merge  True
2  security_model  True
```

See also:

- Examples for the method `pyhelpers.dbms.MSSQL.read_table()`.

MSSQL.read_table

`MSSQL.read_table(table_name, schema_name=None, column_names=None, conditions=None, chunk_size=None, save_as=None, data_dir=None, **kwargs)`

Read data from a table.

Parameters

- **table_name** (*str*) – name of a table in the currently-connected database
- **schema_name** (*str or None*) – name of a schema, defaults to *DEFAULT_SCHEMA* when *schema_name=None*

- **column_names** (*list or tuple or None*) – column name(s), defaults to all columns when `column_names=None`
- **conditions** (*str or None*) – conditions in a SQL query statement, defaults to `None`
- **chunk_size** (*int or None*) – number of rows to include in each chunk (if specified), defaults to `None`
- **save_as** (*str or None*) – file extension (if specified) for saving table data locally, defaults to `None`
- **data_dir** (*str or None*) – directory where the table data is to be saved, defaults to `None`
- **kwargs** – [optional] parameters of `pandas.read_sql`

Returns data of the queried table

Return type `pandas.DataFrame`

Examples:

```
>>> from pyhelpers.dbms import MSSQL
>>> from pyhelpers._cache import example_dataframe

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.read_table(table_name='MSreplication_options')
  optname  value  ...  revision  install_failures
0  transactional  True  ...      0              0
1      merge  True  ...      0              0
2  security_model  True  ...      0              0

[3 rows x 6 columns]

>>> mssql.read_table(table_name='MSreplication_options', column_names=['optname'])
  optname
0  transactional
1      merge
2  security_model

>>> # Create a new database for testing
>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
```

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```

City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> test_table_name = 'example_df'
>>> testdb.import_data(example_df, table_name=test_table_name, index=True, verbose=2)
To import data into [dbo].[example_df] at <server_name>@localhost:1433/testdb
? [No]|Yes: yes
Importing the data into the table [dbo].[example_df] ... Done.

>>> # Retrieve the imported data
>>> example_df_ret = testdb.read_table(table_name=test_table_name, index_col='City')
>>> example_df_ret
           Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> # Drop/Delete the testing database [testdb]
>>> testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

```

See also:

- Examples for the method `pyhelpers.dbms.MSSQL.import_data()`.

MSSQL.schema_exists`MSSQL.schema_exists(schema_name)`

Check whether a schema exists.

Parameters `schema_name` (*str*) – name of a schema in the currently-connected database

Returns whether the schema exists

Return type `bool`

Examples:

```

>>> from pyhelpers.dbms import MSSQL

>>> testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

>>> testdb.schema_exists('dbo')
True

```

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```
>>> testdb.schema_exists('test_schema') # (if the schema [test_schema] does not exist)
False

>>> testdb.drop_database(verbose=True) # Delete the database [testdb]
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.
```

MSSQL.specify_conn_str

MSSQL.specify_conn_str(database_name=None, auth=None, password=None)

Specify a string used for establishing a connection.

Parameters

- **database_name** (*str* or *None*) – name of a database, defaults to the name of the currently-connected database when database=None
- **auth** (*str* or *None*) – authentication method (used for establish the connection), defaults to the current authentication method when auth=None
- **password** (*str* or *int* or *None*) – user's password; when password=None (default), it is required to manually type in the correct password to connect the PostgreSQL server

Returns connection string

Return type str

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> conn_str = mssql.specify_conn_str()
>>> conn_str
'DRIVER={ODBC Driver 17 for SQL Server};SERVER={localhost};DATABASE={master};Trusted_...
```

MSSQL.table_exists

MSSQL.table_exists(table_name, schema_name=None)

Check whether a table exists.

Parameters

- **table_name** (*str*) – name of a table
- **schema_name** (*str* or *None*) – name of a schema, defaults to `DEFAULT_SCHEMA` when schema_name=None

Returns whether the table exists in the currently-connected database

Return type bool

Examples:

```
>>> from pyhelpers.dbms import MSSQL

>>> mssql = MSSQL()
Connecting <server_name>@localhost:1433/master ... Successfully.

>>> mssql.table_exists(table_name='test_table')
False

>>> mssql.get_table_names()
['MSreplication_options',
 'spt_fallback_db',
 'spt_fallback_dev',
 'spt_fallback_usg',
 'spt_monitor']

>>> mssql.table_exists(table_name='MSreplication_options')
True
```

3.7.2 Database tools/utilities

<code>make_database_address(host, port, username)</code>	Make a string of a database address.
<code>get_default_database_address(db_cls)</code>	Get default database address of a given class in the current module.
<code>mssql_to_postgresql(mssql, postgres[, ...])</code>	Copy tables of a database from a Microsoft SQL server to a PostgreSQL server.

make_database_address

`pyhelpers.dbms.make_database_address(host, port, username, database_name='')`

Make a string of a database address.

Parameters

- **host** (*str*) – host name/address of a PostgreSQL server
- **port** (*int* or *str*) – listening port used by PostgreSQL
- **username** (*str*) – username of a PostgreSQL server
- **database_name** (*str* or *None*) – name of a database, defaults to ""

Returns address of a database

Return type str

Examples:

```
>>> from pyhelpers.dbms import make_database_address

>>> db_addr = make_database_address('localhost', 5432, 'postgres', 'postgres')
>>> db_addr
'postgres:***@localhost:5432/postgres'
```

get_default_database_address

`pyhelpers.dbms.get_default_database_address(db_cls)`

Get default database address of a given class in the current module.

Parameters `db_cls` (*object*) – a class representation of a database

Returns default address of database

Return type `str`

Examples:

```
>>> from pyhelpers.dbms import get_default_database_address, PostgreSQL

>>> db_addr = get_default_database_address(db_cls=PostgreSQL)
>>> db_addr
'None:***@None:None'
```

mssql_to_postgresql

`pyhelpers.dbms.mssql_to_postgresql(mssql, postgres, mssql_schema=None, postgres_schema=None, chunk_size=None, excluded_tables=None, file_tables=False, memory_threshold=2.0, update=False, confirmation_required=True, verbose=True)`

Copy tables of a database from a Microsoft SQL server to a PostgreSQL server.

Parameters

- `mssql` (`pyhelpers.dbms.MSSQL`) – name of a Microsoft SQL (source) database
- `postgres` (`pyhelpers.dbms.PostgreSQL`) – name of a PostgreSQL (destination) database
- `mssql_schema` (*str or None*) – name of a schema to be migrated from the SQL Server
- `postgres_schema` (*str or None*) – name of a schema to store the migrated data in the PostgreSQL server
- `chunk_size` (*int or None*) – number of rows in each batch to be read/written at a time, defaults to None
- `excluded_tables` (*list or None*) – names of tables that are excluded from the data migration

- **file_tables** (*bool*) – whether to include FileTables, defaults to False
- **memory_threshold** (*float or int*) – threshold (in GiB) beyond which the data is migrated by partitions, defaults to 2.
- **update** (*bool*) – whether to redo the transfer between the database servers, defaults to False
- **confirmation_required** (*bool*) – whether asking for confirmation to proceed, defaults to True
- **verbose** (*bool or int*) – whether to print relevant information, defaults to True

Examples:

```
>>> from pyhelpers.dbms import mssql_to_postgresql, PostgreSQL, MSSQL
>>> from pyhelpers._cache import example_dataframe

>>> # Connect/create a PostgreSQL database, which is named [testdb]
>>> mssql_testdb = MSSQL(database_name='testdb')
Creating a database: [testdb] ... Done.
Connecting <server_name>@localhost:1433/testdb ... Successfully.

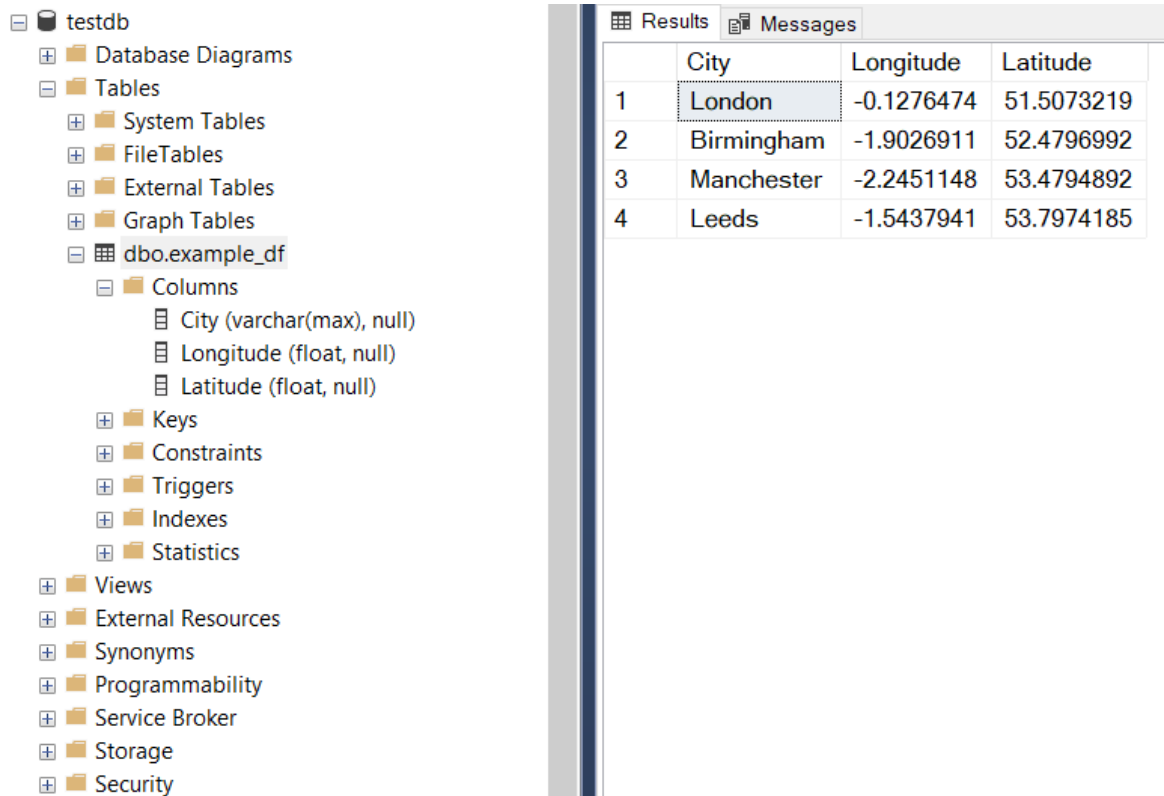
>>> mssql_testdb.database_name
'testdb'

>>> example_df = example_dataframe()
>>> example_df
      Longitude  Latitude
City
London      -0.127647  51.507322
Birmingham -1.902691  52.479699
Manchester  -2.245115  53.479489
Leeds       -1.543794  53.797418

>>> test_table_name = 'example_df'

>>> # Import the example dataframe into a table named [example_df]
>>> mssql_testdb.import_data(example_df, table_name=test_table_name, index=True, verbose=2)
To import data into [dbo].[example_df] at <server_name>@localhost:1433/testdb
? [No]|Yes: yes
Importing the data into the table [dbo].[example_df] ... Done.

>>> mssql_testdb.get_column_names(table_name=test_table_name)
['City', 'Longitude', 'Latitude']
```



The screenshot displays the SQL Server Enterprise Manager interface. On the left, the 'testdb' database is expanded, showing its structure: Database Diagrams, Tables (System Tables, FileTables, External Tables, Graph Tables, and 'dbo.example_df'), Columns (City (varchar(max), null), Longitude (float, null), Latitude (float, null)), Keys, Constraints, Triggers, Indexes, Statistics, Views, External Resources, Synonyms, Programmability, Service Broker, Storage, and Security. On the right, the 'Results' pane shows the data from the 'dbo.example_df' table:

	City	Longitude	Latitude
1	London	-0.1276474	51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 19: The table `[dbo].[example_df]` in the Microsoft SQL Server database `[testdb]`.

```
>>> # Create an instance for a PostgreSQL database, which is also named "testdb"
>>> postgres_testdb = PostgreSQL(database_name='testdb')
Password (postgres@localhost:5432): ***
Creating a database: "testdb" ... Done.
Connecting postgres:***@localhost:5432/testdb ... Successfully.

>>> # For now, the newly-created database doesn't contain any tables
>>> postgres_testdb.get_table_names()
[]

>>> # Copy the example data from the SQL Server to the PostgreSQL "testdb" (under "public")
>>> mssql_to_postgresql(mssql=mssql_testdb, postgres=postgres_testdb)
To copy tables from [testdb] (MSSQL) to "testdb" (PostgreSQL)
? [No]|Yes: yes
Processing tables ...
(1/1) Copying [dbo].[example_df] to "public"."example_df" ... Done.
Completed.

>>> postgres_testdb.get_table_names()
['example_df']
```

The screenshot shows a PostgreSQL database interface. On the left, a sidebar displays the database structure for 'testdb', including 'public' schema and its contents. The 'public' schema is expanded, showing various database objects. The 'example_df' table is selected. The main area shows the 'Query Editor' with a SQL query: `SELECT * FROM public.example_df`. Below the query editor, the 'Data Output' tab is active, displaying a table with 4 rows and 4 columns: 'City', 'Longitude', and 'Latitude' (all with double precision), and an unnamed column. The data rows are: 1 London, 2 Birmingham, 3 Manchester, and 4 Leeds.

	City text	Longitude double precision	Latitude double precision
1	London	-0.1276474	51.5073219
2	Birmingham	-1.9026911	52.4796992
3	Manchester	-2.2451148	53.4794892
4	Leeds	-1.5437941	53.7974185

Fig. 20: The table “*dbo*.”*example_df*” in the PostgreSQL database “*testdb*”.

```
>>> # Drop/delete the created databases
>>> mssql_testdb.drop_database(verbose=True)
To drop the database [testdb] from <server_name>@localhost:1433
? [No]|Yes: yes
Dropping [testdb] ... Done.

>>> postgres_testdb.drop_database(verbose=True)
To drop the database "testdb" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "testdb" ... Done.
```

Chapter 4

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Chapter 5

Tutorial

This brief tutorial provides a few examples for each of the *modules* to demonstrate that what *pyhelpers* could offer to assist us in performing data manipulation tasks in our day-to-day work.

5.1 Preparation - Create a data set

To begin with, let's use *NumPy* and *Pandas* to create an example data set, which is used throughout this tutorial.

Note:

- *NumPy* and *Pandas* are installed along with the installation of *pyhelpers* as they are among the dependencies of the package.
-

For demonstration purposes, firstly, we can use the function `numpy.random.rand` to generate a 100-by-100 Numpy array of random samples drawn from a standard uniform distribution, and name it `random_array`:

```
>>> import numpy as np # Import NumPy and abbreviate it to 'np'
>>> np.random.seed(0) # Ensure that the generated array data is reproducible
>>> random_array = np.random.rand(100, 100)
>>> random_array
array([[0.5488135 , 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.5736796 , 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.1419334 ],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
```

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```
0.81357508]])

>>> random_array.shape # Check the shape of the array
(100, 100)
```

Then, we use the class `pandas.DataFrame` to transform `random_array` into a Pandas data frame, which is presented in tabular form, and name it `data_frame`:

```
>>> import pandas as pd # Import Pandas and abbreviate it to 'pd'

>>> data_frame = pd.DataFrame(random_array, columns=['col_' + str(x) for x in range(100)])
>>> data_frame
```

	col_0	col_1	col_2	...	col_97	col_98	col_99
0	0.548814	0.715189	0.602763	...	0.020108	0.828940	0.004695
1	0.677817	0.270008	0.735194	...	0.254356	0.058029	0.434417
2	0.311796	0.696343	0.377752	...	0.862192	0.972919	0.960835
3	0.906555	0.774047	0.333145	...	0.356707	0.016329	0.185232
4	0.401260	0.929291	0.099615	...	0.401714	0.248413	0.505866
...
95	0.029929	0.985128	0.094747	...	0.369907	0.910011	0.142890
96	0.616935	0.202908	0.288809	...	0.215006	0.143577	0.933162
97	0.891112	0.268674	0.840285	...	0.573680	0.737291	0.225198
98	0.269698	0.738825	0.807145	...	0.948368	0.881307	0.141933
99	0.884982	0.197014	0.568613	...	0.758430	0.023787	0.813575

```
[100 rows x 100 columns]
```

[See also the example of *saving data as a Pickle file*.]

5.2 Alter settings for display of data

The module `pyhelpers.settings` can be used to alter a few frequently-used parameters (of GDAL, Matplotlib, NumPy and Pandas) such that the working environment is adapted to suit our own preferences. For example, we could apply the function `np_preferences()` with its default parameters whereby we may have a 'neater' view of the `random_array`:

```
>>> from pyhelpers.settings import np_preferences

>>> # To round the numbers to four decimal places
>>> np_preferences() # By default, reset=False and precision=4

>>> random_array
array([[0.5488, 0.7152, 0.6028, 0.5449, 0.4237, ..., 0.1832, 0.5865, 0.0201, 0.8289, 0.0047],
       [0.6778, 0.2700, 0.7352, 0.9622, 0.2488, ..., 0.4905, 0.2274, 0.2544, 0.0580, 0.4344],
       [0.3118, 0.6963, 0.3778, 0.1796, 0.0247, ..., 0.2243, 0.0978, 0.8622, 0.9729, 0.9608],
       [0.9066, 0.7740, 0.3331, 0.0811, 0.4072, ..., 0.9590, 0.3554, 0.3567, 0.0163, 0.1852],
       [0.4013, 0.9293, 0.0996, 0.9453, 0.8695, ..., 0.2717, 0.4554, 0.4017, 0.2484, 0.5059],
       ...,
       [0.0299, 0.9851, 0.0947, 0.4510, 0.8387, ..., 0.1239, 0.2947, 0.3699, 0.9100, 0.1429],
       [0.6169, 0.2029, 0.2888, 0.4451, 0.5472, ..., 0.4776, 0.8664, 0.2150, 0.1436, 0.9332],
       [0.8911, 0.2687, 0.8403, 0.7570, 0.9954, ..., 0.9835, 0.4088, 0.5737, 0.7373, 0.2252],
       [0.2697, 0.7388, 0.8071, 0.2006, 0.3087, ..., 0.5063, 0.2319, 0.9484, 0.8813, 0.1419],
       [0.8850, 0.1970, 0.5686, 0.9310, 0.5645, ..., 0.5504, 0.3972, 0.7584, 0.0238, 0.8136]])
```

To reset the display, we can set `reset=True` by which the altered parameters are reset to their default values:

```
>>> np_preferences(reset=True)

>>> random_array
array([[0.54881350, 0.71518937, 0.60276338, ..., 0.02010755, 0.82894003,
        0.00469548],
       [0.67781654, 0.27000797, 0.73519402, ..., 0.25435648, 0.05802916,
        0.43441663],
       [0.31179588, 0.69634349, 0.37775184, ..., 0.86219152, 0.97291949,
        0.96083466],
       ...,
       [0.89111234, 0.26867428, 0.84028499, ..., 0.57367960, 0.73729114,
        0.22519844],
       [0.26969792, 0.73882539, 0.80714479, ..., 0.94836806, 0.88130699,
        0.14193340],
       [0.88498232, 0.19701397, 0.56861333, ..., 0.75842952, 0.02378743,
        0.81357508]])
```

Note:

- Basically, the function `np_preferences()` inherits the functionality of `numpy.set_printoptions`, but with some modifications.

For another example, the function `pd_preferences()` alters a few [Pandas options and settings](#), such as representation and maximum number of columns when displaying a Pandas DataFrame. Applying the function with its default parameters should allow us to view all the 100 columns and the precision of numbers changes to four decimal places.

```
>>> from pyhelpers.settings import pd_preferences

>>> pd_preferences() # By default, reset=False and precision=4

>>> data_frame
   col_0  col_1  col_2  col_3  col_4  col_5  col_6  col_7  col_8  col_9  col_10  col_11 ...
0  0.5488  0.7152  0.6028  0.5449  0.4237  0.6459  0.4376  0.8918  0.9637  0.3834  0.7917  0.5289 ...
1  0.6778  0.2700  0.7352  0.9622  0.2488  0.5762  0.5920  0.5723  0.2231  0.9527  0.4471  0.8464 ...
2  0.3118  0.6963  0.3778  0.1796  0.0247  0.0672  0.6794  0.4537  0.5366  0.8967  0.9903  0.2169 ...
3  0.9066  0.7740  0.3331  0.0811  0.4072  0.2322  0.1325  0.0534  0.7256  0.0114  0.7706  0.1469 ...
4  0.4013  0.9293  0.0996  0.9453  0.8695  0.4542  0.3267  0.2327  0.6145  0.0331  0.0156  0.4288 ...
..  ...    ...    ...    ...    ...    ...    ...    ...    ...    ...    ...    ...
95 0.0299  0.9851  0.0947  0.4510  0.8387  0.4216  0.2488  0.4140  0.8239  0.0449  0.4888  0.1935 ...
96 0.6169  0.2029  0.2888  0.4451  0.5472  0.1754  0.5955  0.6072  0.4085  0.2007  0.3339  0.0980 ...
97 0.8911  0.2687  0.8403  0.7570  0.9954  0.1634  0.8974  0.0570  0.6731  0.6692  0.9157  0.2279 ...
98 0.2697  0.7388  0.8071  0.2006  0.3087  0.0087  0.3848  0.9011  0.4013  0.7590  0.0574  0.5879 ...
99 0.8850  0.1970  0.5686  0.9310  0.5645  0.2116  0.2650  0.6786  0.7470  0.5918  0.2814  0.1868 ...

[100 rows x 100 columns]
```

Note:

- Here the columns from 'col_12' to 'col_99' are omitted from the above demonstration due to the limit of the page width.

Similarly, the function `pd_preferences()` also offers a parameter `reset`, which defaults to `False`; by setting `reset=True`, the altered parameters are reset to their default values. In addition, we can also set `reset='all'` to reset all Pandas options to their default values, if needed.

```
>>> pd_preferences(reset=True)

>>> data_frame
   col_0    col_1    col_2  ...   col_97    col_98    col_99
0  0.548814  0.715189  0.602763  ...  0.020108  0.828940  0.004695
1  0.677817  0.270008  0.735194  ...  0.254356  0.058029  0.434417
2  0.311796  0.696343  0.377752  ...  0.862192  0.972919  0.960835
3  0.906555  0.774047  0.333145  ...  0.356707  0.016329  0.185232
4  0.401260  0.929291  0.099615  ...  0.401714  0.248413  0.505866
..    ...    ...    ...    ...    ...    ...    ...
95 0.029929  0.985128  0.094747  ...  0.369907  0.910011  0.142890
96 0.616935  0.202908  0.288809  ...  0.215006  0.143577  0.933162
97 0.891112  0.268674  0.840285  ...  0.573680  0.737291  0.225198
98 0.269698  0.738825  0.807145  ...  0.948368  0.881307  0.141933
99 0.884982  0.197014  0.568613  ...  0.758430  0.023787  0.813575

[100 rows x 100 columns]
```

Note:

- The functions that are currently available in the module `pyhelpers.settings` handle only a few parameters for the author's personal preference. We may change the source code as appropriate to adapt the settings to different tastes.

5.3 Specify a directory or a file path

The module `pyhelpers.dir` offers to assist with manipulating folders/directories. For example, the function `cd()` returns an absolute path to the current working directory or, if specified, to a subdirectory or a file any level deep from the current working directory:

```
>>> from pyhelpers.dir import cd
>>> import os

>>> cwd = cd()  # The current working directory

>>> # Relative path of `cwd` to the current working directory
>>> rel_path_cwd = os.path.relpath(cwd)
>>> print(rel_path_cwd)
.
```

To specify a path to a temporary folder, named "pyhelpers_tutorial":

```
>>> # Name of a temporary folder for this tutorial
>>> dir_name = "pyhelpers_tutorial"
```

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```
>>> # Path to the folder "pyhelpers_tutorial"
>>> path_to_dir = cd(dir_name)

>>> # Relative path of the directory
>>> rel_dir_path = os.path.relpath(path_to_dir)
>>> print(rel_dir_path)
pyhelpers_tutorial
```

Check whether the directory "pyhelpers_tutorial\" exists:

```
>>> print(f'The directory "{rel_dir_path}\\" exists? {os.path.exists(path_to_dir)}')
The directory "pyhelpers_tutorial\" exists? False
```

If the directory "pyhelpers_tutorial\" does not exist, we could set the parameter `mkdir=True` by which the directory should be created as we specify the path:

```
>>> # Set `mkdir` to be `True` to create a folder named "pyhelpers_tutorial"
>>> path_to_dir = cd(dir_name, mkdir=True)

>>> # Check again whether the directory "pyhelpers_tutorial\" exists
>>> print(f'The directory "{rel_dir_path}\\" exists? {os.path.exists(path_to_dir)}')
The directory "pyhelpers_tutorial\" exists? True
```

When we specify a sequence of names (in order with a filename being the last), the function `cd()` would assume that all the names prior to the filename are folder names, which specify a path to the file. For example, let's specify a path to a file named "quick_start.dat":

```
>>> # Name of a file
>>> filename = "quick_start.dat"

>>> # Path to the file named "quick_start.dat"
>>> path_to_file = cd(dir_name, filename) # path_to_file = cd(path_to_dir, filename)

>>> # Relative path of the file "quick_start.dat"
>>> rel_file_path = os.path.relpath(path_to_file)
>>> print(rel_file_path)
pyhelpers_tutorial\quick_start.dat
```

If any of the folders/subfolders of a specified path does not exist, setting `mkdir=True` should enable the function `cd()` to create all the missing ones along the path. For example, let's specify a data directory, named "data", which is contained within the folder "pyhelpers_tutorial":

```
>>> # Path to a data directory
>>> data_dir = cd("pyhelpers_tutorial", "data") # equivalent to `cd(path_to_dir, "data")`

>>> # Relative path of the data directory
>>> rel_data_dir = os.path.relpath(data_dir)
>>> print(rel_data_dir)
pyhelpers_tutorial\data
```

We can use the function `is_dir()` to examine whether `data_dir` (or `rel_data_dir`) specifies a path (or a relative path) to a directory:

```
>>> from pyhelpers.dir import is_dir

>>> # Check whether `rel_data_dir` specifies a (relative) path to a directory
>>> print(f'`rel_data_dir` specifies a directory pathname? {is_dir(rel_data_dir)}')
`rel_data_dir` specifies a directory pathname? True

>>> # Check whether the data directory exists
>>> print(f'The directory "{rel_data_dir}" exists? {os.path.exists(rel_data_dir)}')
The directory "pyhelpers_tutorial\data\" exists? False
```

For another example, let's specify a path to a Pickle file, named "dat.pickle", in the directory "pyhelpers_tutorial\data\":

```
>>> # Filename of a Pickle file
>>> pickle_filename = "dat.pickle"

>>> # Path to the Pickle file, i.e. cd("pyhelpers_tutorial", "data", "dat.pickle")
>>> path_to_pickle = cd(data_dir, pickle_filename)

>>> # Relative path of the Pickle file
>>> rel_pickle_path = os.path.relpath(path_to_pickle)
>>> print(rel_pickle_path)
pyhelpers_tutorial\data\dat.pickle
```

Examine `rel_pickle_path` (or `path_to_pickle`):

```
>>> # Check whether `rel_pickle_path` specifies a directory
>>> print(f'`rel_pickle_path` specifies a directory? {os.path.isdir(rel_pickle_path)}')
`rel_pickle_path` specifies a directory? False

>>> # Check whether the file "dat.pickle" exists
>>> print(f'The file "{rel_pickle_path}" exists? {os.path.exists(rel_pickle_path)}')
The file "pyhelpers_tutorial\data\dat.pickle" exists? False
```

Let's now set the parameter `mkdir` to be `True`:

```
>>> path_to_pickle = cd(data_dir, pickle_filename, mkdir=True)
>>> rel_data_dir = os.path.relpath(data_dir)

>>> # Check again whether the data directory exists
>>> print(f'The directory "{rel_data_dir}" exists? {os.path.exists(rel_data_dir)}')
The directory "pyhelpers_tutorial\data\" exists? True

>>> # Check again whether the file "dat.pickle" exists
>>> print(f'The file "{rel_pickle_path}" exists? {os.path.exists(rel_pickle_path)}')
The file "pyhelpers_tutorial\data\dat.pickle" exists? False
```

[See also the example of *saving data as a Pickle file*.]

To delete the directory "pyhelpers_tutorial" (and all contained within it), we can use the function `delete_dir()`:

```
>>> from pyhelpers.dir import delete_dir

>>> # Delete the directory "pyhelpers_tutorial\"
>>> delete_dir(path_to_dir, verbose=True)
```

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```
The directory "pyhelpers_tutorial\" is not empty.
Confirmed to delete it
? [No]|Yes: yes
Deleting "pyhelpers_tutorial\" ... Done.
```

5.4 Save data to / load data from a Pickle file

The module `pyhelpers.store` can facilitate tasks such as saving our data to, and loading the data from, file-like objects of some popular formats, such as `CSV`, `JSON` and `Pickle`. For example, we could save the `data_frame` that has been created in the [Preparation](#tutorial-preparation) section as a `Pickle` file by using the functions `save_pickle()` and retrieve it later by using `load_pickle()`. Firstly, let's save `data_frame` to `path_to_pickle`, which has been specified in the *Specify a directory or a file path* section:

```
>>> from pyhelpers.store import save_pickle, load_pickle

>>> # Write `data_frame` to the file "dat.pickle"
>>> save_pickle(data_frame, path_to_pickle, verbose=True)
Saving "dat.pickle" to "pyhelpers_tutorial\data\" ... Done.
```

Now, we can retrieve the data from `path_to_pickle` and store the retrieved data in another variable named `df_retrieved`:

```
>>> df_retrieved = load_pickle(path_to_pickle, verbose=True)
Loading "pyhelpers_tutorial\data\dat.pickle" ... Done.
```

Check whether `df_retrieved` is equal to `data_frame` (namely, whether they have the same shape and elements):

```
>>> print(f`df_retrieved` is equal to `data_frame`? {df_retrieved.equals(data_frame)})
`df_retrieved` is equal to `data_frame`? True
```

Before we move on, let's delete again the `Pickle` file (i.e. `path_to_pickle`) and the directory created in the above example:

```
>>> delete_dir(path_to_dir, verbose=True)
The directory "pyhelpers_tutorial\" is not empty.
Confirmed to delete it
? [No]|Yes: yes
Deleting "pyhelpers_tutorial\" ... Done.
```

Note:

- In the module `store`, some functions such as `save_spreadsheet()` and `save_spreadsheets()` may require `openpyxl`, `XlsxWriter` or `xlrd`, which are NOT essential dependencies for the installation of `pyhelpers`. We could install them as needed via an appropriate method such as `pip install`.

5.5 Convert coordinates between OSGB36 and WGS84

The module `pyhelpers.geom` can assist us in manipulating geometric and geographical data. For example, we can use the function `osgb36_to_wgs84()` to convert coordinates from OSGB36 (British national grid) to WGS84 (latitude and longitude):

```
>>> from pyhelpers.geom import osgb36_to_wgs84

>>> # To convert coordinate of a single point (530034, 180381):
>>> easting, northing = 530039.558844, 180371.680166 # London

>>> longitude, latitude = osgb36_to_wgs84(easting, northing) # Longitude and latitude
>>> (longitude, latitude)
(-0.12764738750268856, 51.507321895400686)
```

We could also use the function to convert an array of OSGB36 coordinates:

```
>>> from pyhelpers._cache import example_dataframe

>>> example_df = example_dataframe(osgb36=True)
>>> example_df
```

	Easting	Northing
City		
London	530039.558844	180371.680166
Birmingham	406705.887014	286868.166642
Manchester	383830.039036	398113.055831
Leeds	430147.447354	433553.327117

```

>>> xy_array = example_df.to_numpy()
>>> eastings, northings = xy_array.T

>>> lonlat_array = osgb36_to_wgs84(eastings, northings, as_array=True)
>>> lonlat_array
array([[ -0.12764739,  51.5073219],
       [-1.90269109,  52.4796992],
       [-2.24511479,  53.4794892],
       [-1.54379409,  53.7974185]])
```

Similarly, we can convert from the (longitude, latitude) back to (easting, northing) by using the function `wgs84_to_osgb36()`:

```
>>> from pyhelpers.geom import wgs84_to_osgb36

>>> longitudes, latitudes = lonlat_array.T

>>> xy_array_ = wgs84_to_osgb36(longitudes, latitudes, as_array=True)
>>> xy_array_
array([[530039.55972534, 180371.67967567],
       [406705.88783629, 286868.16621896],
       [383830.03985454, 398113.05550332],
       [430147.44820845, 433553.32682598]])
```

Note:

- Conversion of coordinates between different systems may inevitably introduce errors, which

are mostly negligible.

Check whether `xy_array_` is almost equal to `xy_array`:

```
>>> eq_res = np.array_equal(np.round(xy_array, 2), np.round(xy_array_, 2))
>>> print(f'`xy_array_` is almost equal to `xy_array`? {eq_res}')
`xy_array_` is almost equal to `xy_array`? True
```

5.6 Find similar texts

The module `pyhelpers.text` can assist us in manipulating textual data. For example, suppose we have a word `'angle'`, which is stored in a `str`-type variable named `word`, and a list of words, which is stored in a `list`-type variable named `lookup_list`; if we'd like to find from the list a one that is most similar to `'angle'`, we can use the function `find_similar_str()`:

```
>>> from pyhelpers.text import find_similar_str

>>> word = 'angle'
>>> lookup_list = ['Anglia',
...                'East Coast',
...                'East Midlands',
...                'North and East',
...                'London North Western',
...                'Scotland',
...                'South East',
...                'Wales',
...                'Wessex',
...                'Western']

>>> # Find the most similar word to 'angle'
>>> result_1 = find_similar_str(word, lookup_list)
>>> result_1
'Anglia'
```

By default, the function relies on `difflib` - a Python built-in module - to perform the task. Alternatively, we could also make use of an open-source package, `FuzzyWuzzy`, via setting the parameter `method='fuzzywuzzy'`:

```
>>> # Find the most similar word to 'angle' by using FuzzyWuzzy
>>> result_2 = find_similar_str(word, lookup_list, method='fuzzywuzzy')
>>> result_2
'Anglia'
```

Note:

- The package `FuzzyWuzzy` is NOT an essential dependency for the installation of `pyhelpers>=1.3.0`_`. We need to install it (e.g. via `pip install`) to make the function run successfully with setting `method='fuzzywuzzy'`.
- In previous versions of `pyhelpers` (i.e. `<=1.2.14`_`), optional values for the parameter `method` include `'fuzzywuzzy'` and `'nltk'`. The latter has been replaced with `'difflib'` since `1.2.15`.

5.7 Download an image file

The module `pyhelpers.ops` provides a miscellany of helper functions that may assist with various operations. For example, we can use the function `download_file_from_url()` to download a file from a given URL.

Let's now try to download an image file of [Python logo](#) from its [home page](#). Firstly, we need to specify the URL of the image file:

```
>>> from pyhelpers.ops import download_file_from_url

>>> # URL of a .png file of the Python logo
>>> url = 'https://www.python.org/static/community_logos/python-logo-master-v3-TM.png'
```

Then, we need to specify a directory where we'd like to save the image file, and a filename for it; let's say we want to name the file "python-logo.png" and save it to the directory "pyhelpers_tutorial\images\":

```
>>> python_logo_filename = "python-logo.png"
>>> # python_logo_file_path = cd("pyhelpers_tutorial", "images", python_logo_filename)
>>> python_logo_file_path = cd(path_to_dir, "images", python_logo_filename)

>>> # Download the .png file of the Python logo
>>> download_file_from_url(url, python_logo_file_path, verbose=False)
```

The parameter `verbose` is by default `False`. If we set `verbose=True`, the function would print out relevant information about the download as the file is being downloaded.

Note:

- When `verbose=True` (or `verbose=1`), the function requires an open-source package `tqdm`, which is NOT an essential dependency for installing `pyhelpers>=1.2.15`. We can just install the dependency package via `pip install` to make the function run successfully.

Assuming `tqdm` has been installed in our working environment, try:

```
>>> download_file_from_url(url, python_logo_file_path, if_exists='replace', verbose=True)
"pyhelpers_tutorial\images\python-logo.png": 81.6kB [00:00, 10.8MB/s]
```

Note:

- '...MB/s' shown at the end of the output above is an estimated speed of downloading the file, which varies depending on network conditions at the time of running the function.
- Setting `if_exists='replace'` (default) allows us to download the image file again and replace the one that was just downloaded to the specified destination.

Now let's have a look at the downloaded image file by using [Pillow](#):

```
>>> from PIL import Image

>>> python_logo = Image.open(python_logo_file_path)
>>> python_logo.show()
```



Fig. 21: The Python Logo (for illustration in the brief tutorial).

Note:

- In [Jupyter Notebook](#), we may use `IPython.display.Image` to display the image in the notebook by running `IPython.display.Image(python_logo_file_path)`.
-

To delete "pyhelpers_tutorial\" and the download directory "pyhelpers_tutorial\images\", again, we can use the function `delete_dir()`:

```
>>> delete_dir(path_to_dir, confirmation_required=False, verbose=True)
Deleting "pyhelpers_tutorial\" ... Done.
```

Setting the parameter `confirmation_required=False` can allow us to delete the directory straightaway without having to type yes to confirm the action. This is actually implemented through the function `confirmed()`, which is also from the module `pyhelpers.ops` and can be helpful especially when we'd like to impose a manual confirmation before proceeding with certain actions. For example:

```
>>> from pyhelpers.ops import confirmed

>>> # We can specify any prompting message as to what needs to be confirmed.
>>> if confirmed(prompt="Continue? ..."):
...     print("OK! Go ahead.")
Continue? ... [No] | Yes: yes
OK! Go ahead.
```

Note:

- What we type to respond to the prompting message is case-insensitive. It doesn't have to be precisely Yes to make the function return True; something like yes, Y or ye can do the job as well. If we type no or n, it returns False.
 - The function also provides a parameter `confirmation_required`, which defaults to True. If setting `confirmation_required=False`, a confirmation is not required, in which case this
-

function will become ineffective as it just returns True.

5.8 Work with a PostgreSQL server

The module `pyhelpers.dbms` offers a convenient way of communicating with databases, such as PostgreSQL.

Note:

- The current release of pyhelpers is only able to deal with PostgreSQL as the module `pyhelpers.dbms` needs to be further developed to work with other types of databases.
-

The class `PostgreSQL`, for example, could assist us in executing some basic SQL statements on a PostgreSQL database server. To demonstrate it works, let's start with importing the class:

```
>>> from pyhelpers.dbms import PostgreSQL
```

5.8.1 Connect to a database

Now, we can create an instance of the class `PostgreSQL` to connect a PostgreSQL server by specifying the key parameters, including host, port, username, database_name and password.

Note:

- If we leave host, port, username and database_name unspecified, their default arguments (namely, host='localhost', port=5432, username='postgres' and database_name='postgres') are passed to instantiate the class, in which case we would connect to the default PostgreSQL server (as is installed on a PC).
 - If the specified database_name does not exist, it will be automatically created along with the class instantiation.
 - If we prefer not to specify explicitly the parameter password, we could just leave it. In that case, we will be asked to type in the password manually when instantiating the class.
-

For example, let's create an instance named `postgres`, and we'd like to establish a connection with a database named `"pyhelpers_tutorial"`, which is hosted at the default PostgreSQL server:

```
>>> postgres = PostgreSQL(database_name="pyhelpers_tutorial")
Password (postgres@localhost:5432): ***
Creating a database: "pyhelpers_tutorial" ... Done.
Connecting postgres:***@localhost:5432/pyhelpers_tutorial ... Successfully.
```

We can use `pgAdmin` - the most popular graphical management tool for PostgreSQL - to check whether the database `"pyhelpers_tutorial"` exists now in the Databases tree of the default server, as illustrated in [Fig. 22](#):

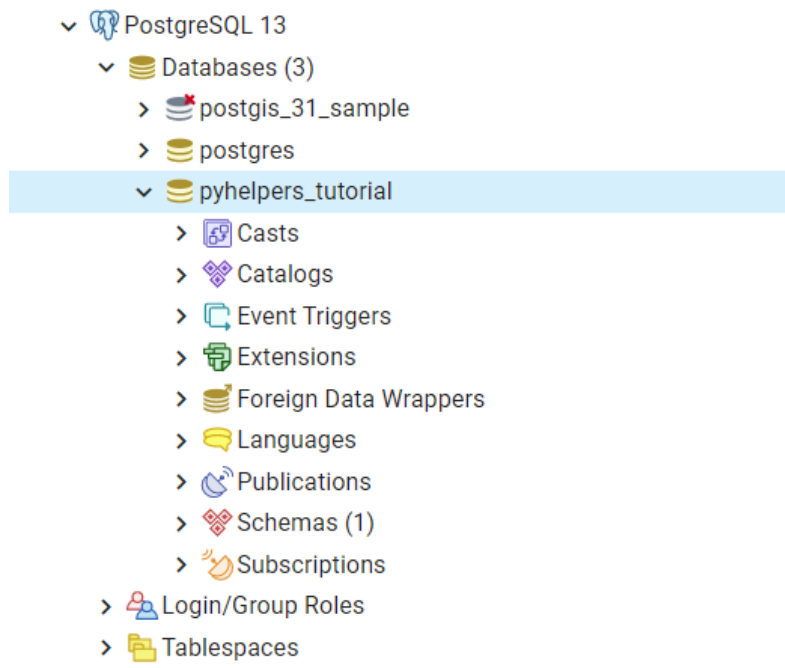


Fig. 22: The database “*pyhelpers_tutorial*”.

Alternatively, we could also use the method `database_exists()`:

```
>>> res = postgres.database_exists("pyhelpers_tutorial")
>>> print(f'The database "pyhelpers_tutorial" exists? {res}')
The database "pyhelpers_tutorial" exists? True

>>> print(f'We are currently connected to the database "{postgres.database_name}"')
We are now connected with the database "pyhelpers_tutorial".
```

In the same server, we can create multiple databases. For example, let’s now create another database named “*pyhelpers_tutorial_alt*” by using the method `create_database()`:

```
>>> postgres.create_database("pyhelpers_tutorial_alt", verbose=True)
Creating a database: "pyhelpers_tutorial_alt" ... Done.
```

As we can see in Fig. 23, the database “*pyhelpers_tutorial_alt*” has now been added to the default *Databases* tree:

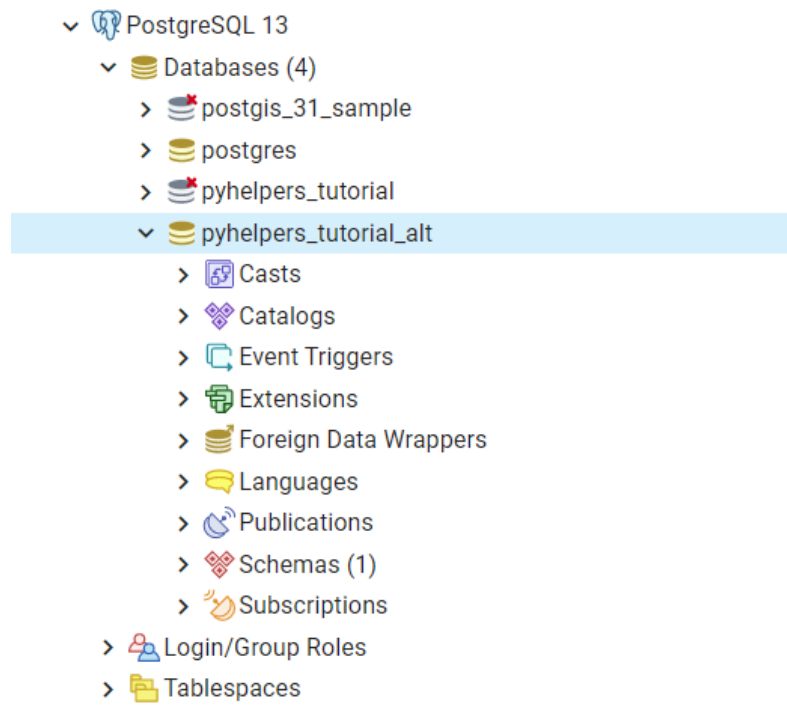


Fig. 23: The database “*pyhelpers_tutorial_alt*”.

Note:

- When a new database is created, the instance postgres disconnects the currently-connected database and connect to the new one.

Check whether “*pyhelpers_tutorial_alt*” is the database being connected now:

```
>>> res = postgres.database_exists("pyhelpers_tutorial_alt")
>>> print(f'The database "pyhelpers_tutorial_alt" exists? {res}')
The database "pyhelpers_tutorial_alt" exists? True

>>> print(f'We are currently connected to the database "{postgres.database_name}"')
We are now connected with the database "pyhelpers_tutorial_alt".
```

To connect again to “*pyhelpers_tutorial*”, we can use the method `connect_database()`:

```
>>> postgres.connect_database("pyhelpers_tutorial", verbose=True)
Connecting postgres:***@localhost:5432/pyhelpers_tutorial ... Successfully.

>>> print(f'We are currently connected to the database "{postgres.database_name}"')
We are now connected with the database "pyhelpers_tutorial".
```

5.8.2 Import data into a database

With the established connection to the database, we can use the method `import_data()` to import the `data_frame`, which has been created in the *Preparation* section, into a table named “*df_table*” under the default schema “*public*”:

```
>>> postgres.import_data(data=data_frame, table_name="df_table", verbose=2)
To import data into "public"."df_table" at postgres:***@localhost:5432/pyhelpers_tutorial
? [No]|Yes: yes
Importing the data into the table "public"."df_table" ... Done.
```

We should now be able to see the table in pgAdmin, as illustrated in [Fig. 24](#):

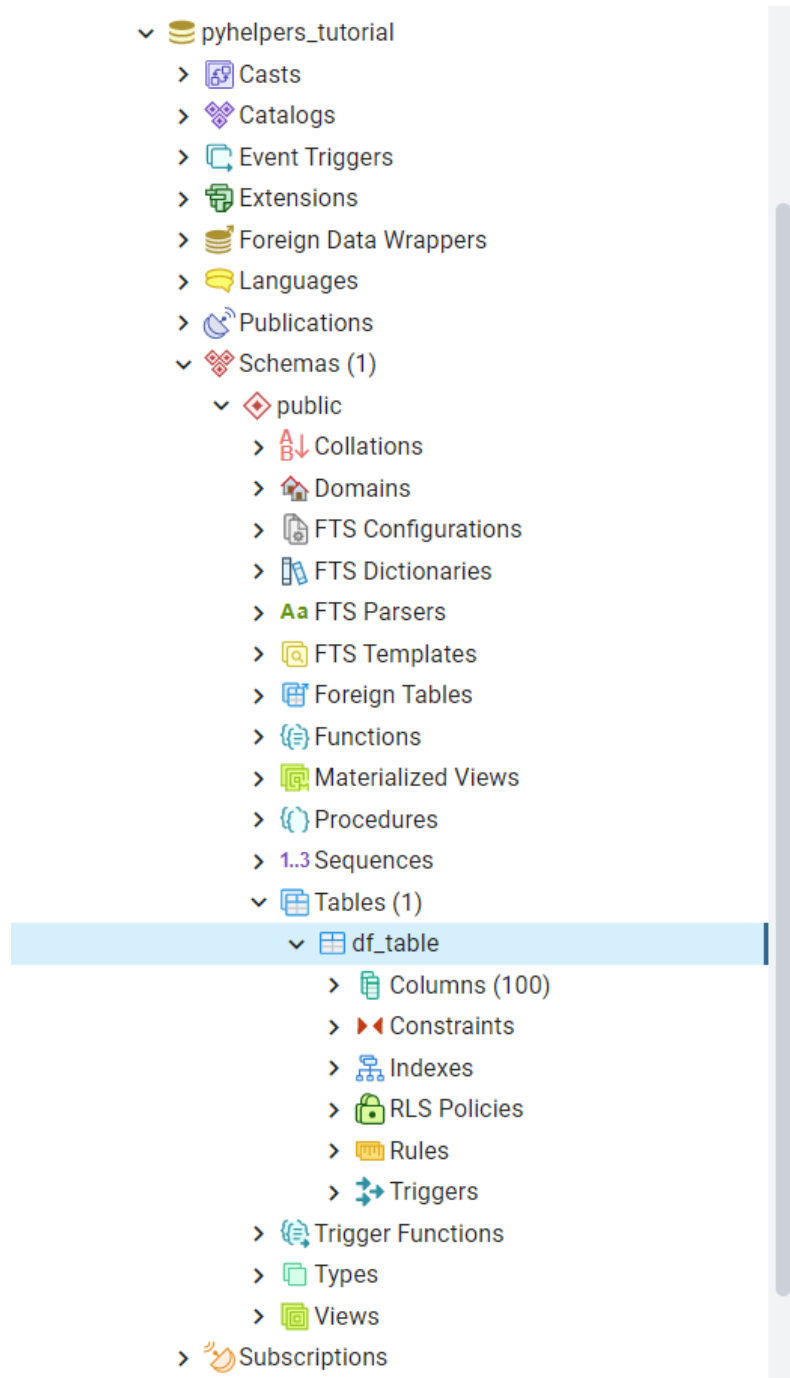


Fig. 24: The table “*public*.”*df_table*”.

The method `import_data()` relies on the method `pandas.DataFrame.to_sql()`, with the parameter `method` being set to be 'multi' by default. Optionally, it can also take the method `psql_insert_copy()` as an argument to significantly speed up importing data into a database, especially when the data size is fairly large.

Let's now try to import the same data into a table named “*df_table_alt*” by setting `method=postgres.psql_insert_copy`:

```
>>> postgres.import_data(
...     data=data_frame, table_name="df_table_alt", method=postgres.psql_insert_copy, verbose=2)
To import data into "public"."df_table_alt" at postgres:***@localhost:5432/pyhelpers_tutorial
? [No]|Yes: yes
Importing the data into the table "public"."df_table_alt" ... Done.
```

In pgAdmin, we can see the table has been added to the *Tables* list, as illustrated in Fig. 25:

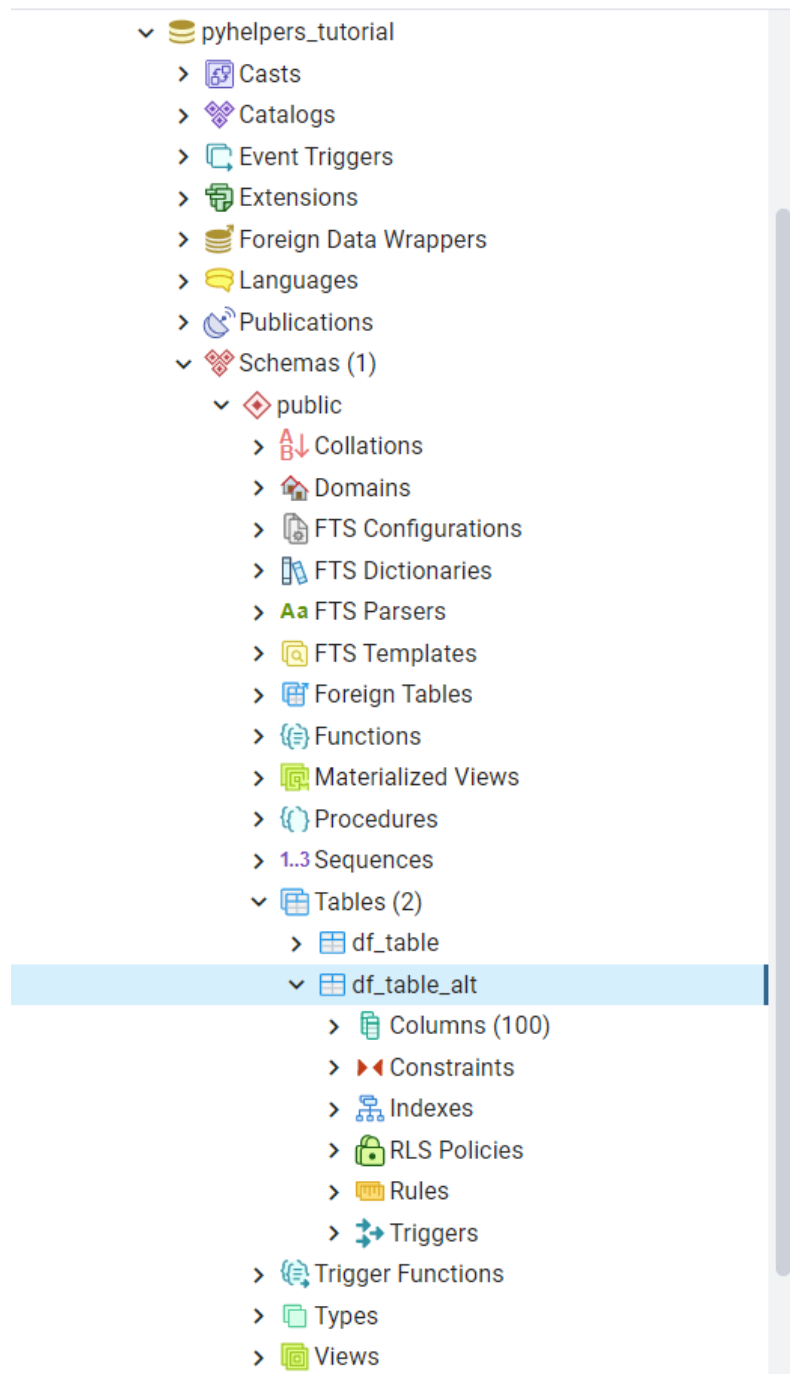


Fig. 25: The table “public”.”df_table_alt”.

5.8.3 Fetch data from a database

To retrieve the imported data, we can use the method `read_table()`:

```
>>> df_retrieval_1 = postgres.read_table(table_name="df_table")

>>> res = df_retrieval_1.equals(data_frame)
>>> print(f"`df_retrieval_1` is equal to `data_frame`? {res}")
`df_retrieval_1` is equal to `data_frame`? True
```

Alternatively, we can also use the method `read_sql_query()`, which serves as a more flexible way of reading/querying data. It takes PostgreSQL statements, and could be much faster when the queried table is fairly large. Let's try this method to fetch the same data from the table `"df_table_alt"`:

```
>>> df_retrieval_2 = postgres.read_sql_query(sql_query='SELECT * FROM "public"."df_table_alt"')

>>> res = df_retrieval_2.round(8).equals(df_retrieval_1.round(8))
>>> print(f"`df_retrieval_2` is equal to `df_retrieval_1`? {res}")
`df_retrieval_2` is equal to `df_retrieval_1`? True
```

Note:

- For the method `read_sql_query()`, any PostgreSQL statement that is passed to the parameter `sql_query` should NOT end with `' ; '`.

5.8.4 Drop data

Before we leave this notebook, let's clear up the databases and tables we've created.

We can delete/drop a table (e.g. `"df_table"`) by using the method `drop_table()`:

```
>>> postgres.drop_table(table_name="df_table", verbose=True)
To drop the table "public"."df_table" from postgres:***@localhost:5432/pyhelpers_tutorial
? [No]|Yes: yes
Dropping "public"."df_table" ... Done.
```

To delete/drop a database, we can use the method `drop_database()`:

```
>>> # Drop "pyhelpers_tutorial" (i.e. the currently connected database)
>>> postgres.drop_database(verbose=True)
To drop the database "pyhelpers_tutorial" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "pyhelpers_tutorial" ... Done.

>>> # Drop "pyhelpers_tutorial_alt"
>>> postgres.drop_database(database_name="pyhelpers_tutorial_alt", verbose=True)
To drop the database "pyhelpers_tutorial_alt" from postgres:***@localhost:5432
? [No]|Yes: yes
Dropping "pyhelpers_tutorial_alt" ... Done.
```

Check which database is the one being currently connected:

```
>>> print(f"We are currently connected with the database \"{postgres.database_name}\".")  
We are currently connected with the database "postgres".
```

Now we have removed all the databases created above, and restored the PostgreSQL server to its original status.

This is the end of the *Tutorial*.

Any issues regarding the use of the package are all welcome and should be logged/reported onto the [Bug Tracker](#).

For more details and examples, check [Modules](#).

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