Functions, organization, external packages, and string formatting

ESS 116 | Fall 2024

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(Modified from Ethan Campbell and Katy Christensen's materials for UW's Ocean 215)

What we'll cover in this lesson

1. Creating functions
2. Organizing your code and installing external packages
3. String formatting

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Code organization

You want your code to be easily read and debugged.

It is often best to “tell a story” with your code...

Put the code in a logical order with intuitive blocks.

Each cell in Colab should have a specific task.

Use comments to denote what is happening, but not too many!

Put functions early in the code in the order that you use them later.

```
# # Run this code only once per notebook, then comment it out
# !pip install netcdf4
```

```
import numpy as np
import xarray as xr
import matplotlib.pyplot as plt

import sys
sys.path.append('/content/drive/My Drive')
import my_module

from google.colab import drive
drive.mount('/content/drive')
```

```
def func_to_read_the_data(*Arguments*):
  # Do something with arguments
  # Return something
  return


def func_to_analyze_the_data(*Arguments*):
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def func_to_plot_the_data(*Arguments*):
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```

```
filepath =
filename =

# Read the data
data = func_to_read_the_data()

# Any additional reading statements

```

```
# Analyze the data
analysis = func_to_analyze_the_data()

# Any additional analysis

```

```
# Save/plot the data
func_to_plot_the_data

```

```
# Any additional plotting
```

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Mount your drive

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Create different functions for frequently used code

It usually helps to create functions that do a specific tasks (e.g. read, analyze, plot)

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Read the data

Analyze the data

Plot the data

One cell per plot helps with organization

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Consistent code style helps keep everything organized

PEP 8 -- Style Guide for Python Code

https://www.python.org/dev/peps/pep-0008/#code-lay-out

Consistent code style helps keep everything organized

Blank Lines

Surround top-level function and class definitions with two blank lines.

Method definitions inside a class are surrounded by a single blank line.

Extra blank lines may be used (sparingly) to separate groups of related functions. Blank lines may be omitted between a bunch of related one-liners (e.g. a set of dummy implementations).

Use blank lines in functions, sparingly, to indicate logical sections.

Imports

- Imports should usually be on separate lines:

```
# Correct:
import os
import sys
```

```
# Wrong:
import sys, os
```

It's okay to say this though:

```
# Correct:
from subprocess import Popen, PIPE
```

- Imports are always put at the top of the file, just after any module comments and docstrings, and before module globals and constants.

Maximum Line Length

Limit all lines to a maximum of 79 characters.

For flowing long blocks of text with fewer structural restrictions (docstrings or comments), the line length should be limited to 72 characters.

Limiting the required editor window width makes it possible to have several files open side-by-side, and works well when using code review tools that present the two versions in adjacent columns.

Comments

Comments that contradict the code are worse than no comments. Always make a priority of keeping the comments up-to-date when the code changes!

Comments should be complete sentences. The first word should be capitalized, unless it is an identifier that begins with a lower case letter (never alter the case of identifiers!).

Block comments generally consist of one or more paragraphs built out of complete sentences, with each sentence ending in a period.

You should use two spaces after a sentence-ending period in multi- sentence comments, except after the final sentence.

Ensure that your comments are clear and easily understandable to other speakers of the language you are writing in.

Python coders from non-English speaking countries: please write your comments in English, unless you are 120% sure that the code will never be read by people who don't speak your language.

Consistent code style helps keep everything organized

Whitespace in Expressions and Statements

- Immediately inside parentheses, brackets or braces:

```
# Correct:
spam(ham[1], {eggs: 2})
```

```
# Wrong:
spam( ham[ 1 ], { eggs: 2 } )
```

- Between a trailing comma and a following close parenthesis:

```
# Correct:
foo = (0,)
```

```
# Wrong:
bar = (0, )
```

- Immediately before a comma, semicolon, or colon:

```
# Correct:
if x == 4: print x, y; x, y = y, x
```

```
# Wrong:
if x == 4 : print x , y ; x , y = y , x
```

- However, in a slice the colon acts like a binary operator, and should have equal amounts on either side (treating it as the operator with the lowest priority). In an extended slice, both colons must have the same amount of spacing applied. Exception: when a slice parameter is omitted, the space is omitted:

```
# Correct:
ham[1:9], ham[1:9:3], ham[:9:3], ham[1::3], ham[1:9:]
ham[lower:upper], ham[lower:upper:], ham[lower::step]
ham[lower+offset : upper+offset]
ham[: upper_fn(x) : step_fn(x)], ham[:: step_fn(x)]
ham[lower + offset : upper + offset]
```

```
# Wrong:
ham[lower + offset:upper + offset]
ham[1: 9], ham[1 :9], ham[1:9 :3]
ham[lower : : upper]
ham[ : upper]
```

- More than one space around an assignment (or other) operator to align it with another:

```
# Correct:
x = 1
y = 2
long_variable = 3
```

```
# Wrong:
x             = 1
y             = 2
long_variable = 3
```

- Immediately before the open parenthesis that starts the argument list of a function call:

```
# Correct:
spam(1)
```

```
# Wrong:
spam (1)
```

- Immediately before the open parenthesis that starts an indexing or slicing:

```
# Correct:
dct['key'] = lst[index]
```

```
# Wrong:
dct ['key'] = lst [index]
```

More than one space around an assignment (or other) operator to align it with another:

```
# Correct:
x = 1
y = 2
long_variable = 3
```

Consistent code style helps keep everything organized

```
1 import this
```

```
The Zen of Python, by Tim Peters

Beautiful is better than ugly.
Explicit is better than implicit.
Simple is better than complex.
Complex is better than complicated.
Flat is better than nested.
Sparse is better than dense.
Readability counts.
Special cases aren't special enough to break the rules.
Although practicality beats purity.
Errors should never pass silently.
Unless explicitly silenced.
In the face of ambiguity, refuse the temptation to guess.
There should be one-- and preferably only one --obvious way to do it.
Although that way may not be obvious at first unless you're Dutch.
Now is better than never.
Although never is often better than *right* now.
If the implementation is hard to explain, it's a bad idea.
If the implementation is easy to explain, it may be a good idea.
Namespaces are one honking great idea -- let's do more of those!
```

Packages

A package is a directory of Python modules.

We have already seen a number of packages!

```
import matplotlib.pyplot as plt
```

To use the modules in a package you have to import it.

Useful packages for Oceanography

Already in Colab

1. numpy
2. scipy
3. xarray
4. Pandas
5. datetime
6. matplotlib.pyplot

Not in Colab

1. netCDF4
2. Cartopy
3. cmocean
4. Gibbs Seawater (gsw)

How to find what packages Colab already has

```
!pip list
```

```
Package                       Version
----------------------------- ----------
absl-py                       0.10.0
alabaster                     0.7.12
albumentations                0.1.12
altair                        4.1.0
argon2-cffi                   20.1.0
asgiref                       3.3.1
astor                         0.8.1
astropy                       4.1
astunparse                    1.6.3
async-generator               1.10
atari-py                      0.2.6
atomicwrites                  1.4.0
attrs                         20.3.0
audioread                     2.1.9
autograd                      1.3
Babel                         2.9.0
backcall                      0.2.0
beautifulsoup4                4.6.3
bleach                        3.2.1
blis                          0.4.1
bokeh                         2.1.1
Bottleneck                    1.3.2
branca                        0.4.1
bs4                           0.0.1
CacheControl                  0.12.6
cachetools                    4.1.1
catalogue                     1.0.0
certifi                       2020.11.8
cffi                          1.14.3
cftime                        1.3.0
chainer                       7.4.0
chardet                       3.0.4
click                         7.1.2
cloudpickle                   1.3.0
cmake                         3.12.0
cmdstanpy                     0.9.5
colorlover                    0.3.0
community                     1.0.0b1
contextlib2                   0.5.5
convertdate                   2.3.0
coverage                      3.7.1
coveralls                     0.5
crcmod                        1.7
cufflinks                     0.17.3
cvxopt                        1.2.5
cvxpy                         1.0.31
cycler                        0.10.0
cymem                         2.0.4
Cython                        0.29.21
daft                          0.0.4
dask                          2.12.0
dataclasses                   0.8
datascience                   0.10.6
debugpy                       1.0.0
decorator                     4.4.2
defusedxml                    0.6.0
descartes                     1.1.0
dill                          0.3.3
distributed                   1.25.3
Django                        3.1.3
dlib                          19.18.0
dm-tree                       0.1.5
docopt                        0.6.2
docutils                      0.16
dopamine-rl                   1.0.5
earthengine-api               0.1.238
easydict                      1.9
ecos                          2.0.7.post
editdistance                  0.5.3
en-core-web-sm                2.2.5
entrypoints                   0.3
ephem                         3.7.7.1
et-xmlfile                    1.0.1
fa2                           0.3.5
fancyimpute                   0.4.3
fastai                        1.0.61
fastdtw                       0.3.4
fastprogress                  1.0.0
fastrlock                     0.5
fbprophet                     0.7.1
feather-format                0.4.1
filelock                      3.0.12
firebase-admin                4.4.0
fix-yahoo-finance             0.0.22
Flask                         1.1.2
flatbuffers                   1.12
folium                        0.8.3
future                        0.16.0
gast                          0.3.3
GDAL                          2.2.2
gdown                         3.6.4
gensim                        3.6.0
geographiclib                 1.50
geopy                         1.17.0
gin-config                    0.3.0
glob2                         0.7
google                        2.0.3
google-api-core               1.16.0
google-api-python-client      1.7.12
google-auth                   1.17.2
google-auth-httplib2          0.0.4
google-auth-oauthlib          0.4.2
google-cloud-bigquery         1.21.0
google-cloud-bigquery-storage 1.1.0
google-cloud-core             1.0.3
google-cloud-datastore        1.8.0
google-cloud-firestore        1.7.0
google-cloud-language         1.2.0
google-cloud-storage          1.18.1
google-cloud-translate        1.5.0
google-colab                  1.0.0
google-pasta                  0.2.0
google-resumable-media        0.4.1
googleapis-common-protos      1.52.0
googledrivedownloader         0.4
graphviz                      0.10.1
grpcio                        1.33.2
gspread                       3.0.1
gspread-dataframe             3.0.8
gym                           0.17.3
h5py                          2.10.0
HeapDict                      1.0.1
holidays                      0.10.3
holoviews                     1.13.5
html5lib                      1.0.1
httpimport                    0.5.18
httplib2                      0.17.4
httplib2shim                  0.0.3
humanize                      0.5.1
hyperopt                      0.1.2
ideep4py                      2.0.0.po
idna                          2.10
image                         1.5.33
imageio                       2.4.1
imagesize                     1.2.0
imbalanced-learn              0.4.3
imblearn                      0.0
imgaug                        0.2.9
importlib-metadata            2.0.0
importlib-resources           3.3.0
imutils                       0.5.3
inflect                       2.1.0
iniconfig                     1.1.1
intel-openmp                  2020.0.1
intervaltree                  2.1.0
ipykernel                     4.10.1
ipython                       5.5.0
ipython-genutils              0.2.0
ipython-sql                   0.3.9
ipywidgets                    7.5.1
itsdangerous                  1.1.0
jax                           0.2.6
jaxlib                        0.1.57+c
jdcal                         1.4.1
jedi                          0.17.2
jieba                         0.42.1
Jinja2                        2.11.2
joblib                        0.17.0
jpeg4py                       0.1.4
jsonschema                    2.6.0
jupyter                       1.0.0
jupyter-client                5.3.5
jupyter-console               5.2.0
jupyter-core                  4.7.0
jupyterlab-pygments           0.1.2
kaggle                        1.5.9
kapre                         0.1.3.1
Keras                         2.4.3
Keras-Preprocessing           1.1.2
keras-vis                     0.4.1
kiwisolver                    1.3.1
knnimpute                     0.1.0
korean-lunar-calendar         0.2.1
librosa                       0.6.3
lightgbm                      2.2.3
llvmlite                      0.31.0
lmdb                          0.99
lucid                         0.3.8
LunarCalendar                 0.0.9
lxml                          4.2.6
Markdown                      3.3.3
MarkupSafe                    1.1.1
matplotlib                    3.2.2
matplotlib-venn               0.11.6
missingno                     0.4.2
mistune                       0.8.4
mizani                        0.6.0
mkl                           2019.0
mlxtend                       0.14.0
more-itertools                8.6.0
moviepy                       0.2.3.5
mpmath                        1.1.0
msgpack                       1.0.0
multiprocess                  0.70.11.1
multitasking                  0.0.9
murmurhash                    1.0.4
music21                       5.5.0
natsort                       5.5.0
nbclient                      0.5.1
nbconvert                     5.6.1
nbformat                      5.0.8
nest-asyncio                  1.4.3
netCDF4                       1.5.4
networkx                      2.5
nibabel                       3.0.2
nltk                          3.2.5
notebook                      5.3.1
np-utils                      0.5.12.1
numba                         0.48.0
numexpr                       2.7.1
numpy                         1.18.5
nvidia-ml-py3                 7.352.0
oauth2client                  4.1.3
oauthlib                      3.1.0
okgrade                       0.4.3
opencv-contrib-python         4.1.2.30
opencv-python                 4.1.2.30
openpyxl                      2.5.9
opt-einsum                    3.3.0
osqp                          0.6.1
packaging                     20.4
palettable                    3.3.0
pandas                        1.1.4
pandas-datareader             0.9.0
pandas-gbq                    0.13.3
pandas-profiling              1.4.1
pandocfilters                 1.4.3
panel                         0.9.7
param                         1.10.0
parso                         0.7.1
pathlib                       1.0.1
patsy                         0.5.1
pexpect                       4.8.0
pickleshare                   0.7.5
Pillow                        7.0.0
pip                           19.3.1
pip-tools                     4.5.1
plac                          1.1.3
plotly                        4.4.1
plotnine                      0.6.0
pluggy                        0.7.1
portpicker                    1.3.1
prefetch-generator            1.0.1
preshed                       3.0.4
prettytable                   2.0.0
progressbar2                  3.38.0
prometheus-client             0.9.0
promise                       2.3
prompt-toolkit                1.0.18
protobuf                      3.12.4
psutil                        5.4.8
psycopg2                      2.7.6.1
ptyprocess                    0.6.0
py                            1.9.0
pyarrow                       0.14.1
pyasn1                        0.4.8
pyasn1-modules                0.2.8
pycocotools                   2.0.2
pycparser                     2.20
pyct                          0.4.8
pydata-google-auth            1.1.0
pydot                         1.3.0
pydot-ng                      2.0.0
pydotplus                     2.0.2
PyDrive                       1.3.1
pyemd                         0.5.1
pyglet                        1.5.0
Pygments                      2.6.1
pygobject                     3.26.1
pymc3                         3.7
PyMeeus                       0.3.7
pymongo                       3.11.1
pymystem3                     0.2.0
PyOpenGL                      3.1.5
pyparsing                     2.4.7
pyrsistent                    0.17.3
pysndfile                     1.3.8
PySocks                       1.7.1
pystan                        2.19.1.1
pytest                        3.6.4
python-apt                    1.6.5+ubun
python-chess                  0.23.11
python-dateutil               2.8.1
python-louvain                0.14
python-slugify                4.0.1
python-utils                  2.4.0
pytz                          2018.9
pyviz-comms                   0.7.6
PyWavelets                    1.1.1
PyYAML                        3.13
pyzmq                         20.0.0
qtconsole                     4.7.7
QtPy                          1.9.0
regex                         2019.12.
requests                      2.23.0
requests-oauthlib             1.3.0
resampy                       0.2.2
retrying                      1.3.3
rpy2                          3.2.7
rsa                           4.6
scikit-image                  0.16.2
scikit-learn                  0.22.2.p
scipy                         1.4.1
screen-resolution-extra       0.0.0
scs                           2.1.2
seaborn                       0.11.0
Send2Trash                    1.5.0
setuptools                    50.3.2
setuptools-git                1.2
Shapely                       1.7.1
simplegeneric                 0.8.1
six                           1.15.0
sklearn                       0.0
sklearn-pandas                1.8.0
slugify                       0.0.1
smart-open                    3.0.0
sortedcontainers              2.3.0
spacy                         2.2.4
Sphinx                        1.8.5
sphinxcontrib-serializinghtml 1.1.4
sphinxcontrib-websupport      1.2.4
SQLAlchemy                    1.3.20
sqlparse                      0.4.1
srsly                         1.0.4
statsmodels                   0.10.2
sympy                         1.1.1
tables                        3.4.4
tabulate                      0.8.7
tblib                         1.7.0
tensorboard                   2.3.0
tensorboard-plugin-wit        1.7.0
tensorboardcolab              0.0.22
tensorflow                    2.3.0
tensorflow-addons             0.8.3
tensorflow-datasets           4.0.1
tensorflow-estimator          2.3.0
tensorflow-gcs-config         2.3.0
tensorflow-hub                0.10.0
tensorflow-metadata           0.25.0
tensorflow-privacy            0.2.2
tensorflow-probability        0.11.0
termcolor                     1.1.0
terminado                     0.9.1
testpath                      0.4.4
text-unidecode                1.3
textblob                      0.15.3
textgenrnn                    1.4.1
Theano                        1.0.5
tifffile                      2020.9.3
toml                          0.10.2
toolz                         0.11.1
torch                         1.7.0+cu10
torchsummary                  1.5.1
torchtext                     0.3.1
torchvision                   0.8.1+cu10
tornado                       5.1.1
tqdm                          4.41.1
traitlets                     4.3.3
tweepy                        3.6.0
typeguard                     2.7.1
typing-extensions             3.7.4.3
tzlocal                       1.5.1
umap-learn                    0.4.6
uritemplate                   3.0.1
urllib3                       1.24.3
vega-datasets                 0.8.0
wasabi                        0.8.0
wcwidth                       0.2.5
webencodings                  0.5.1
Werkzeug                      1.0.1
wheel                         0.35.1
widgetsnbextension            3.5.1
wordcloud                     1.5.0
wrapt                         1.12.1
xarray                        0.15.1
xgboost                       0.90
xkit                          0.0.0
xlrd                          1.1.0
xlwt                          1.3.0
yellowbrick                   0.9.1
```

How to import external packages to Colab

```
!pip install <package name>
```

To figure out the name to import the package, you can check the documentation! (Example: https://matplotlib.org/cmocean/)

GSW and cmocean

```
!pip install gsw
!pip install cmocean
```

```
# Package management
# Run this cell only once per notebook then comment it out.
#-----------------------------------------------------------------

# This code allows xarray and netCDF4 to work with Google Colab
!pip install netcdf4

# This code installs TEOS-10 gsw
!pip install gsw

# This code installs cmocean
!pip install cmocean

# This code allows cartopy to work with Google Colab
!grep '^deb ' /etc/apt/sources.list | \
  sed 's/^deb /deb-src /g' | \
  tee /etc/apt/sources.list.d/deb-src.list
!apt-get -qq update
!apt-get -qq build-dep python3-cartopy
!pip uninstall -y shapely
!pip install shapely --no-binary shapely
!pip install Cartopy
```

```
import numpy as np
import xarray as xr
import pandas as pd
import gsw
from scipy import stats, interpolate
from datetime import datetime, timedelta

import matplotlib.pyplot as plt
import cmocean

import cartopy.crs as ccrs
import cartopy.feature as cfeature
import matplotlib.ticker as mticker
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
```

GSW and cmocean

```
!pip install gsw
!pip install cmocean
```

```
# # Package management
# # Run this cell only once per notebook then comment it out.
# #-----------------------------------------------------------------

# # This code allows xarray and netCDF4 to work with Google Colab
# !pip install netcdf4

# # This code installs TEOS-10 gsw
# !pip install gsw

# # This code installs cmocean
# !pip install cmocean

# # This code allows cartopy to work with Google Colab
# !grep '^deb ' /etc/apt/sources.list | \
#   sed 's/^deb /deb-src /g' | \
#   tee /etc/apt/sources.list.d/deb-src.list
# !apt-get -qq update
# !apt-get -qq build-dep python3-cartopy
# !pip uninstall -y shapely
# !pip install shapely --no-binary shapely
# !pip install Cartopy
```

```
import numpy as np
import xarray as xr
import pandas as pd
import gsw
from scipy import stats, interpolate
from datetime import datetime, timedelta

import matplotlib.pyplot as plt
import cmocean

import cartopy.crs as ccrs
import cartopy.feature as cfeature
import matplotlib.ticker as mticker
from cartopy.mpl.gridliner import LONGITUDE_FORMATTER, LATITUDE_FORMATTER
```

How to find what modules are in a package

```
dir(<package name>)
```

```
1 dir(gsw)
```

```
['CT_first_derivatives',
 'CT_first_derivatives_wrt_t_exact',
 'CT_freezing',
 'CT_freezing_first_derivatives',
 'CT_freezing_first_derivatives_poly',
 'CT_freezing_poly',
 'CT_from_enthalpy',
 'CT_from_enthalpy_exact',
 'CT_from_entropy',
 'CT_from_pt',
 'CT_from_rho',
 'CT_from_t',
 'CT_maxdensity',
 'CT_second_derivatives',
 'C_from_SP',
 'Fdelta',
 'Helmholtz_energy_ice',
 'Hill_ratio_at_SP2',
 'IPV_vs_fNsquared_ratio',
 'Nsquared',
 'O2sol',
 'O2sol_SP_pt',
 'SAAR',
 'SA_freezing_from_CT',
 'SA_freezing_from_CT_poly',
 'SA_freezing_from_t',
 'SA_freezing_from_t_poly',
 'SA_from_SP',
 'SA_from_SP_Baltic',
 'SA_from_Sstar',
 'SA_from_rho',
 'SP_from_C',
 'SP_from_SA',
 'SP_from_SA_Baltic',
 'SP_from_SK',
 'SP_from_SR',
 'SP_from_Sstar',
 'SP_salinometer',
 'SR_from_SP',
 'Sstar_from_SA',
 'Sstar_from_SP',
```

How to find what modules are in a package

More information on each functions can be found at the documentation:

https://teos-10.github.io/GSW-Python/gsw_flat.html

Or you can get information on a specific function using ?

```
gsw.sigma0?
```

Help ×

```
Signature: gsw.sigma0(SA, CT)
Docstring:
Calculates potential density anomaly with reference pressure
of 0 dbar,
this being this particular potential density minus 1000
kg/m^3.  This
function has inputs of Absolute Salinity and Conservative
Temperature.
This function uses the computationally-efficient expression
for
specific volume in terms of SA, CT and p (Roquet et al.,
2015).

Parameters
----------
SA : array-like
    Absolute Salinity, g/kg
CT : array-like
    Conservative Temperature (ITS-90), degrees C

Returns
-------
sigma0 : array-like, kg/m^3
    potential density anomaly with
    respect to a reference pressure of 0 dbar,
    that is, this potential density - 1000 kg/m^3.
File:      /usr/local/lib/python3.6/dist-
packages/gsw/_wrapped_ufuncs.py
Type:      function
```

What we'll cover in this lesson

1. Creating functions

2. Organizing your code and installing external packages

3. **String formatting**

Formatting strings to fit your needs

Formatting strings makes hard-coding unnecessary

```
1 T = 10
2
3 print('The temperature is 10˚C.')
```

```
The temperature is 10˚C.
```

```
1 T = 10
2
3 print('The temperature is '+str(T)+'˚C.')
```

```
The temperature is 10˚C.
```

<string>.format()

```
1 T = 10
2
3 print('The temperature is {}˚C'.format(T))
```

```
The temperature is 10˚C
```

Formatting strings to fit your needs

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {}˚C, Relative humidity= {}%'.format(T,RH))
```

```
Temperature = 10˚C, Relative humidity= 52%
```

Formatting strings to fit your needs

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {}˚C, Relative humidity= {}%'.format(T,RH))
```

```
Temperature = 10˚C, Relative humidity= 52%
```

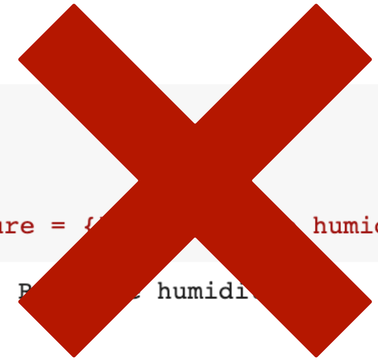
```
1 T = 10
2 RH = 52
3
4 print('Temperature = {}˚C, Relative humidity= {}%'.format(RH,T))
```

```
Temperature = 52˚C, Relative humidity= 10%
```

Formatting strings to fit your needs

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {}˚C, Relative humidity= {}%'.format(T,RH))
```

```
Temperature = 10˚C, Relative humidity= 52%
```



```
1 T = 10
2 RH = 52
3
4 print('Temperature = {
```

```
Temperature = 52˚C, R
```

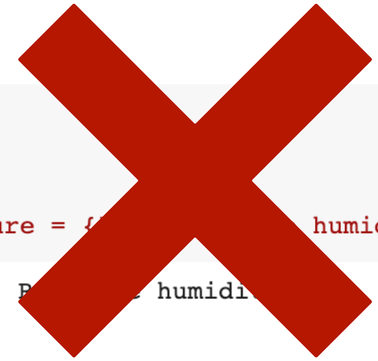
```
1 T = 10
2 RH = 52
3
4 print('Temperature = {1}˚C, Relative humidity= {0}%'.format(RH,T))
```

```
Temperature = 10˚C, Relative humidity= 52%
```

Formatting strings to fit your needs

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {}˚C, Relative humidity= {}%'.format(T,RH))
```

```
Temperature = 10˚C, Relative humidity= 52%
```



```
1 T = 10
2 RH = 52
3
4 print('Temperature = {
```

```
humidity= {}%'.format(RH,T))
```

```
Temperature = 52˚C, R
```

```
humidi
```

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {1}˚C, Relative humidity= {0}%'.format(RH,T))
```

```
Temperature = 10˚C, Relative humidity= 52%
```

```
1 T = 10
2 RH = 52
3
4 print('Temperature = {T}˚C, Relative humidity= {RH}%'.format(RH=RH,T=T))
```

```
Temperature = 10˚C, Relative humidity= 52%
```

You can round the output of a float

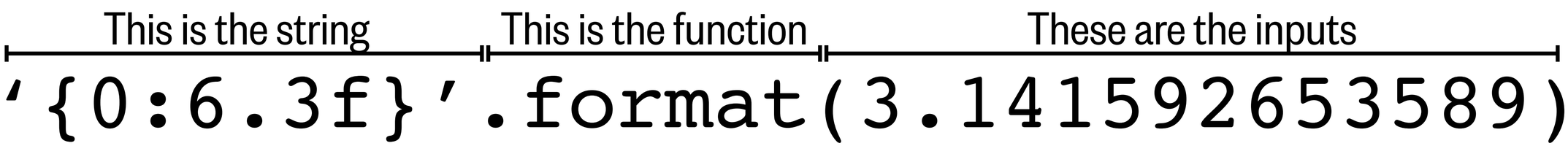
```
1 T = 10.71717
2 RH = 52.517985
3
4 print('Temperature = {T}˚C, Relative humidity= {RH}%'.format(RH=RH,T=T))
```

```
Temperature = 10.71717˚C, Relative humidity= 52.517985%
```

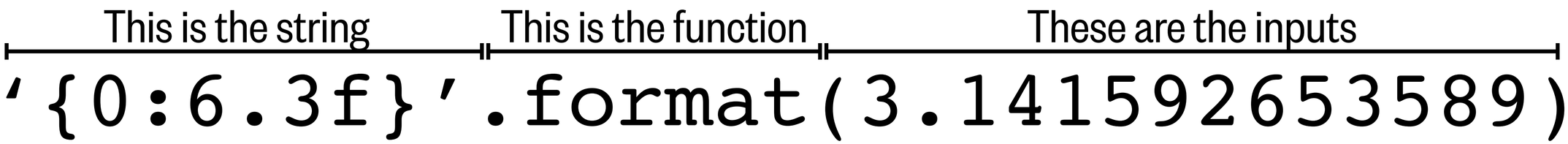
```
1 T = 10.71717
2 RH = 52.517985
3
4 print('Temperature = {T:.2f}˚C, Relative humidity= {RH:.4f}%'.format(RH=RH,T=T))
```

```
Temperature = 10.72˚C, Relative humidity= 52.5180%
```

You can customize the outputs



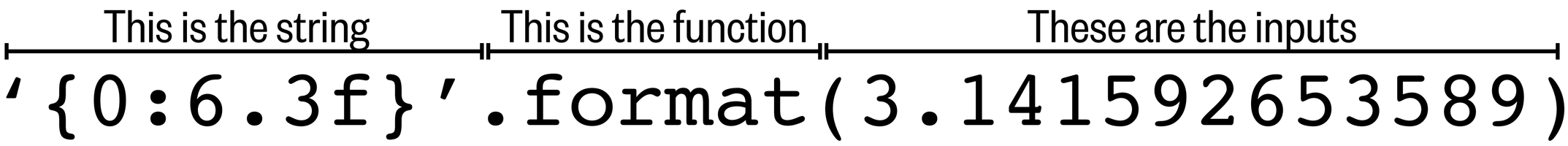
You can customize the outputs



This is the placeholder

- **blank:** the format arguments are in order
- **integer:** the format argument position is known
- **name:** the format argument has keyword arguments

You can customize the outputs

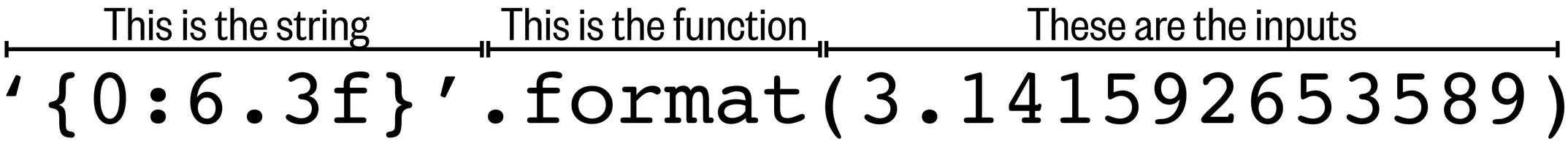


This is the placeholder

This is the number of characters to output

- **blank:** the format arguments are in order
- **integer:** the format argument position is known
- **name:** the format argument has keyword arguments

You can customize the outputs



This is the placeholder

- **blank:** the format arguments are in order
- **integer:** the format argument position is known
- **name:** the format argument has keyword arguments

This is the number of characters to output

This is the number of decimal places to round to

- Only for floats

You can customize the outputs

This is the string | This is the function | These are the inputs

```
'{0:6.3f}'.format(3.141592653589)
```

This is the placeholder

- **blank:** the format arguments are in order
- **integer:** the format argument position is known
- **name:** the format argument has keyword arguments

This is the number of characters to output

This is the number of decimal places to round to

- Only for floats

This is the type of object

- **s:** the input is a string
- **d:** the input is an integer
- **f:** the input is a float
- **e:** the input is an exponential

You can customize the outputs

This is the string | This is the function | These are the inputs

```
'{0:6.3f}'.format(3.141592653589)
```

This is the placeholder

- **blank:** the format arguments are in order
- **integer:** the format argument position is known
- **name:** the format argument has keyword arguments

This is the number of characters to output

This is the number of decimal places to round to

- Only for floats

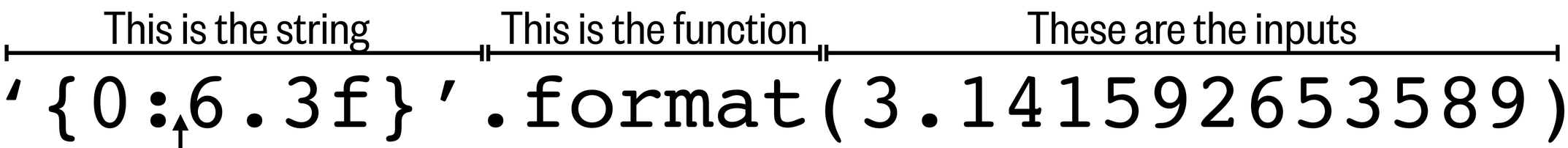
This is the type of object

- **s:** the input is a string
- **d:** the input is an integer
- **f:** the input is a float
- **e:** the input is an exponential

```
1 '{0:6.3f}'.format(3.141592653589)
```

```
' 3.142'
```

You can customize the outputs



Additional formatting can go here.

These are only relevant to number inputs

>	Right-aligned
<	Left-aligned
^	Center-aligned
0	Zero-padded
space	A space is in front of positive numbers, a negative sign is in front of negative numbers
+	A positive sign is in front of positive numbers, a negative sign is in front of negative numbers

String formatting is particularly helpful in for loops

```
filenames = ['D5901105_185.nc','D5901105_186.nc','D5901105_187.nc',
             'D5901105_188.nc','D5901105_189.nc','D5901105_190.nc']

```

```
filenames = []
for index in range(185,191):
  floatstring = 'D5901105_{:03d}.nc'.format(index)
  filenames.append(floatstring)

print(filenames)
```

```
['D5901105_185.nc', 'D5901105_186.nc', 'D5901105_187.nc', 'D5901105_188.nc', 'D5901105_189.nc', 'D5901105_190.nc']
```

String formatting is particularly helpful in for loops

```
filenames = ['D5901105_185.nc','D5901105_186.nc','D5901105_187.nc',
             'D5901105_188.nc','D5901105_189.nc','D5901105_190.nc']

```

```
filenames = []
for index in range(185,191):
  floatstring = 'D5901105_{:03d}.nc'.format(index)
  filenames.append(floatstring)

print(filenames)
```

```
['D5901105_185.nc', 'D5901105_186.nc', 'D5901105_187.nc', 'D5901105_188.nc', 'D5901105_189.nc', 'D5901105_190.nc']
```

```
filenames = []
for index in range(1,7):
  floatstring = 'D5901105_{:03d}.nc'.format(index)
  filenames.append(floatstring)

print(filenames)
```

```
['D5901105_001.nc', 'D5901105_002.nc', 'D5901105_003.nc', 'D5901105_004.nc', 'D5901105_005.nc', 'D5901105_006.nc']
```

String formatting can also be helpful in functions

```
1 def read_profile(floatnum,profnum,filepath):
2   profstring = 'D{0:d}_{1:03d}.nc'.format(floatnum,profnum)
3   print(profstring)
4   data = xr.open_dataset(filepath+profstring)
5   data = data.squeeze()
6   return data
7
8 filepath = 'drive/My Drive/Data_folder/ARGO_floatdata/'
9 data = read_profile(5901105,186,filepath)
10 display(data)
```

```
D5901105_186.nc
```

xarray.Dataset

▶ Dimensions: (N_HISTORY: 4, N_LEVELS: 76, N_PARAM: 4)

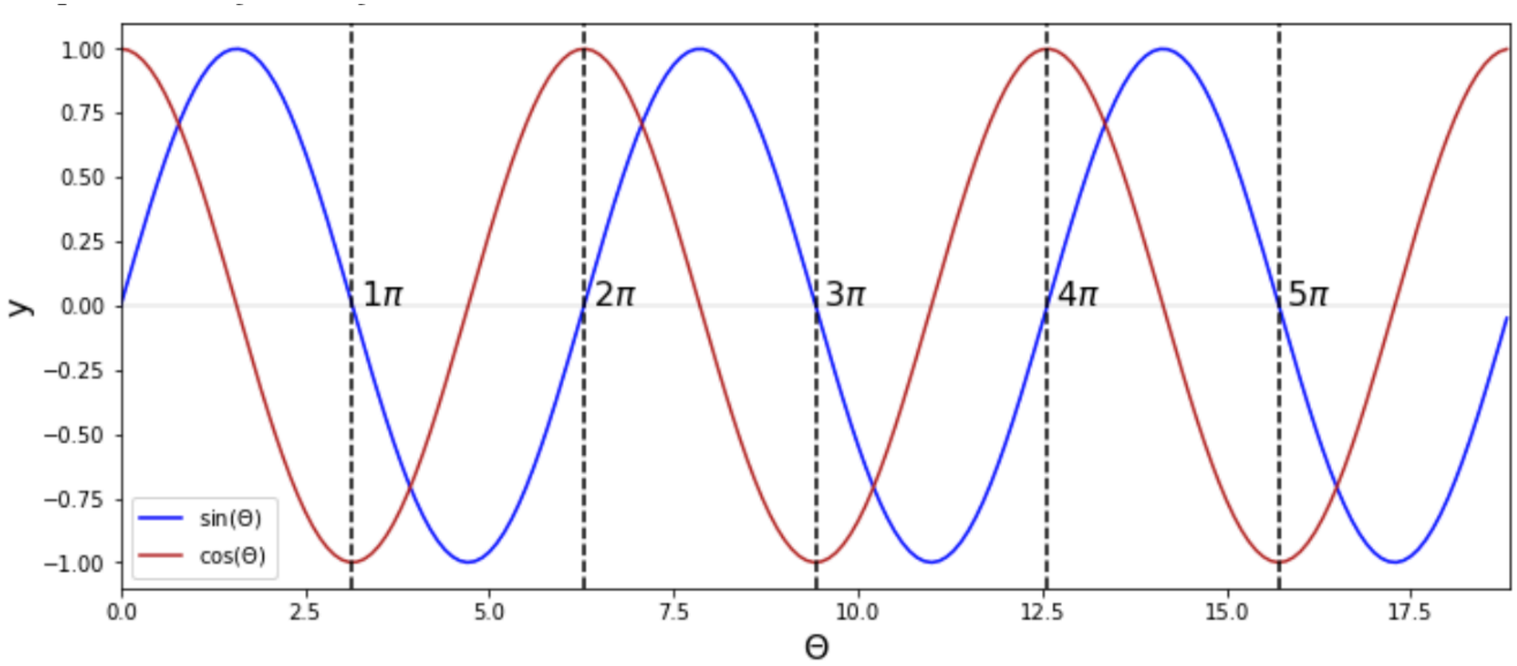
▶ Coordinates: (0)

▶ Data variables: (70)

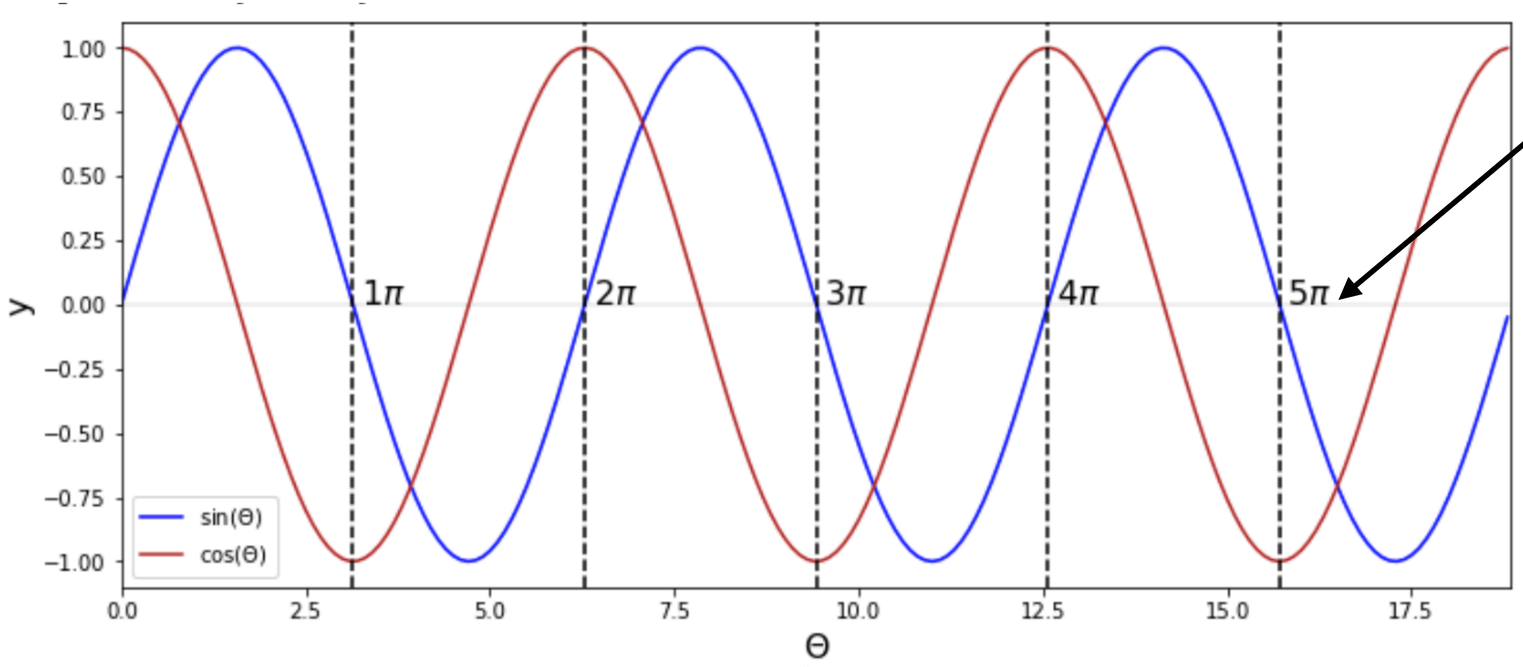
▼ Attributes:

title :	Argo float vertical profile
institution :	AOML
source :	Argo float
history :	2019-02-26T17:55:57Z creation
references :	http://www.argodatamgt.org/Documentation
comment :	free text
user_manual_v…	3.2
Conventions :	Argo-3.2 CF-1.6
featureType :	trajectoryProfile

Adding math symbols to strings on figures



Adding math symbols to strings on figures



'π'

'Θ'

```
theta = np.arange(0,6*np.pi,0.1)
y1 = np.sin(theta)
y2 = np.cos(theta)

fs = 16

fig = plt.figure(figsize=(12,5))
plt.plot(theta,y1,'b',label='sin($\Theta$)')
plt.plot(theta,y2,c='firebrick',label='cos($\Theta$)')

plt.plot([0,6*np.pi],[0,0],'k-',lw=0.25,alpha=0.5)

for index in range(1,6):
  plt.plot([index*np.pi, index*np.pi], [-1.1,1.1],'k--')
  plt.text(index*np.pi+0.1,0,'{}$\pi$'.format(index),fontsize=fs)

plt.xlim([0,6*np.pi])
plt.ylim([-1.1,1.1])
plt.xlabel('$\Theta$',fontsize=fs)
plt.ylabel('y',fontsize=fs)

plt.legend()

```

Adding math symbols to figures

$ $

Insert character text here

Super- and sub- scripts

x^2	O_2	π	σ	Δ	κ	α
x^2	O_2	π	σ	Δ	κ	α
β	ρ	ω	∞	$\sum$	$\pm$	
β	ρ	ω	∞	$\sum$	$\pm$	

For more special symbols, see the documentation

https://matplotlib.org/3.1.1/tutorials/text/mathtext.html