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What is xarray?

For Python / Numpy users

- xarray handles N-dimensional arrays with labels (dimension names & coordinates) and metadata.
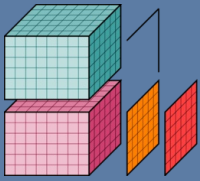
For Python / Pandas users

- xarray is a powerful, pandas-like toolkit for analytics on multi-dimensional arrays.

For scientists familar with the netCDF format

- xarray implements the netCDF data model with a high level Python API.

For scientists working with big datasets

- xarray (with dask) supports efficient, out-of-core computing for datasets that don't fit in memory.

summary   data structures   indexing   aggregation   arithmetics   plotting   out-of-core

numpy.array

```
>>> import numpy as np
>>> a = np.array([[1, 3, 9], [2, 8, 4]])
>>> a
```

```
array([[1, 3, 9],
       [2, 8, 4]])
```

```
>>> a[1, 2]    # get the value at 2nd row and 3rd column
```
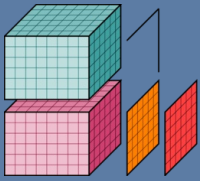
```
4
```

```
>>> a.mean(axis=0)    # compute the mean column-wise
```

```
array([1.5,  5.5,  6.5])
```

Not well supported by numpy:

- array dimensions and indexes often have a meaning, e.g., latitude / longitude and their coordinates.

xarray: multi-dimensional data analysis in Python

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xarray.DataArray

```
>>> import xarray as xr
>>> da = xr.DataArray(a, dims=['latitude', 'longitude'],
                      coords={'longitude':[11, 12, 13], 'latitude':[1, 2]})
>>> da
```

```
<xarray.DataArray (latitude: 2, longitude: 3)>
array([[1, 3, 9],
       [2, 8, 4]])
Coordinates:
  * longitude    (longitude) int64 11 12 13
  * latitude     (latitude) int64 1 2
```

```
>>> da.sel(longitude=13, latitude=2)   # easier to work with coordinate values!
```

```
<xarray.DataArray ()>
array(4)
Coordinates:
    longitude    int64 13
    latitude     int64 2
```
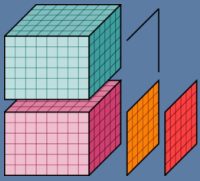
```
>>> da.mean(dim='latitude')    # easier to remember dimension names!
```

```
<xarray.DataArray (longitude: 3)>
array([ 1.5,  5.5,  6.5])
Coordinates:
  * longitude    (longitude) int64 11 12 13
```

summary   data structures   indexing   aggregation   arithmetics   plotting   out-of-core

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xarray.Dataset

A collection of `xarray.DataArray`, a netCDF file...

```
>>> ds = xr.open_dataset('ERA-Int-MonthlyAvg-4D-TUVWZ.nc')
>>> ds
```

```
<xarray.Dataset>
Dimensions:    (latitude: 241, level: 15, longitude: 480, month: 12)
Coordinates:
  * latitude   (latitude) float32 90.0 89.25 88.5 87.75 87.0 ...
  * level      (level) int32 50 100 150 200 300 400 500 600 ...
  * longitude  (longitude) float32 -180.0 -179.25 -178.5 ...
  * month      (month) int64 1 2 3 4 5 6 7 8 9 10 11 12
Data variables:
    u          (month, level, latitude, longitude) float64 10.38 ...
    v          (month, level, latitude, longitude) float64 5.594 ...
    w          (month, level, latitude, longitude) float64 -0.0003052 ...
    z          (month, level, latitude, longitude) float64 1.888e+05 ...
    t          (month, level, latitude, longitude) float64 201.1 ...
Attributes:
    Conventions: CF-1.0
    Info: Monthly ERA-Interim data.
```
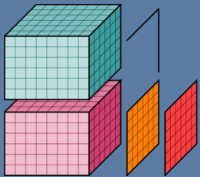
xarray: multi-dimensional data analysis in Python

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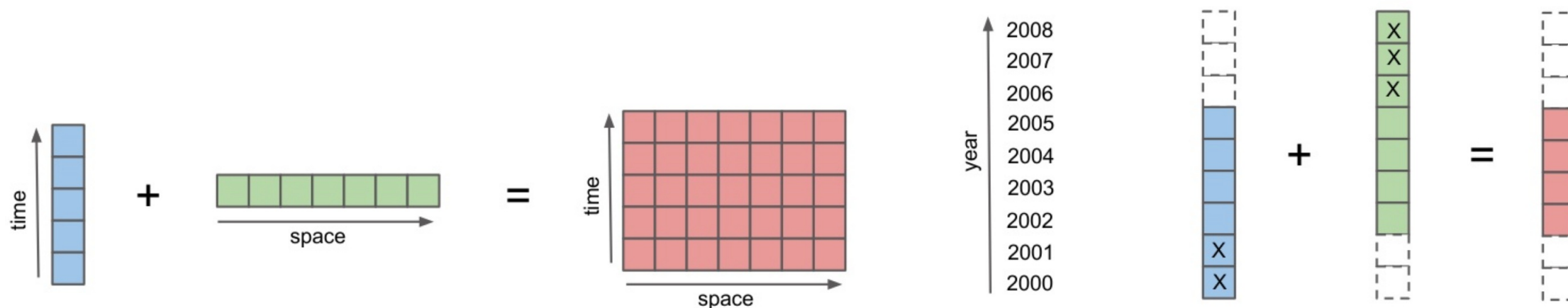
Powerful analytics

- Advanced selection

```
ds.sel(latitude=47.26, method='nearest')   # no need to provide exact coordinate values
```
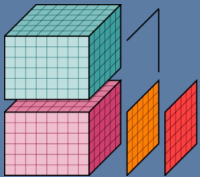
- Aggregation

```
ds.mean(dim=['month', 'longitude'])
```

- Arithmetics

```
ds1 + ds2    # supports automatic broadcasting and alignment!
```

summary   data structures   indexing   aggregation   arithmetics   plotting   out-of-core

Powerful analytics (2)

- Plotting

```
import cartopy.crs as ccrs
ax = plt.axes(projection=ccrs.Robinson())
ds.z.sel(level=1000, month=8).plot(ax=ax, transform=ccrs.PlateCarree());
ax.coastlines();
```


level = 1000, month = 8

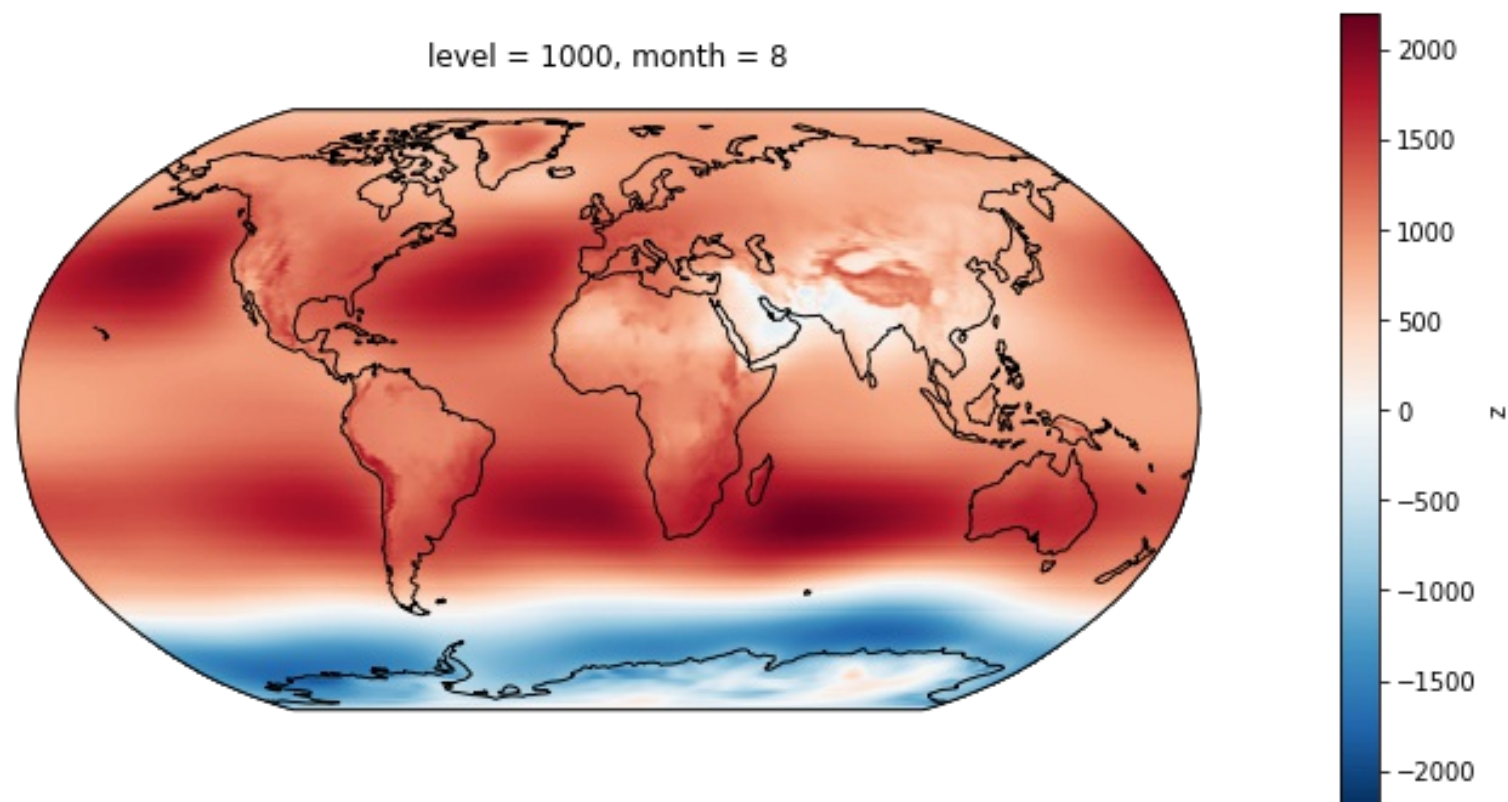# xarray: multi-dimensional data analysis in Python

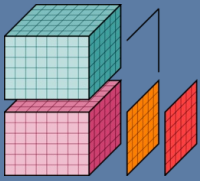Stephan Hoyer (1), Joe Hamman (2), Fabien Maussion (3) and Benoît Bovy (4)

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Powerful analytics (3)

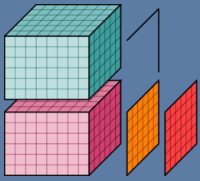- Out-of-core computing

```python
big_ds = xr.open_mfdataset('data*.nc') # lazy loading of many netCDF files
                                       # (>1GB) into a single xarray.Dataset

big_ds.mean(dim=['longitude', 'latitude'])  # lazy computation

big_ds.load()    # triggers efficient, multi-core computation (using dask)
```

- ... and more!

xarray: multi-dimensional data analysis in Python

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xarray

- Open source

- Very good integration with other Python libraries for scientific computing (SciPy / PyData Stack)

- Documentation: http://xarray.pydata.org

- Repository: https://github.com/pydata/xarray

- 60 contributors (still growing)

- Latest release: v0.9.2 (02.04.2017)

- Umbrellas (no funding): Python for Data & NumFOCUS