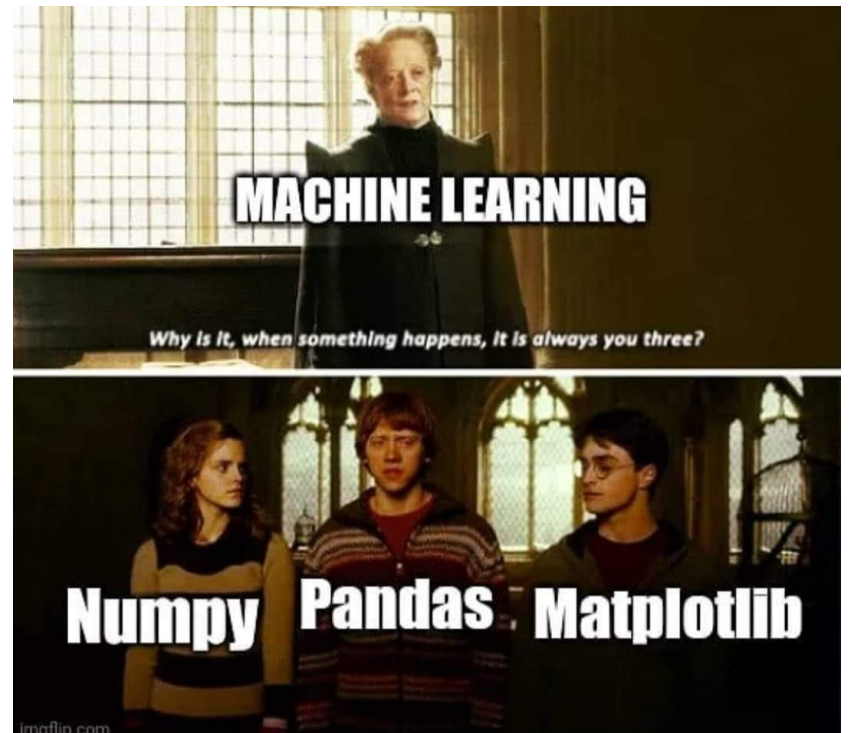


# Python Libraries: numpy and matplotlib

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# Numpy (Numeric Python)

- Library used for high performance computing and data analysis
  - High-level math functions involving arrays/matrices
  - Fast numerical computations like matrix multiplication; linear algebra/fourier transform etc
- Very efficient for large arrays of data
  - Stores data contiguously → less memory, faster operation (10-100 times faster)
    - 1000 x 1000 matrix multiply
      - Python triple loop takes > 10 min.
      - Numpy takes ~0.03 seconds
  - Batch operations can be managed without writing loops (vectorization)

# Ndarray (n-dimensional-array)

- ndarray used for storage of homogeneous data
  - All elements the same type
- Supports convenient slicing, indexing and efficient vectorized computation
- Every array must have a shape and a dtype (data type)
  - Vector: array in single dimension
  - Matrix: array in two dimensions
  - Tensor: 3-D or higher dimensional arrays

- Create arrays (see `arrays.py`)
  - Different data types, dimensions
  - Conversion from one type to another
  - Copy vs view
- Create special arrays (see `special-arrays.py`)
  - `eye`, `zeros`, `ones`, `random`, `in a range`
- Indexing of arrays
  - Slicing, stepping, accessing columns/rows
  - Printing rows, elements
- Shaping of arrays
  - Convert 1D to 2D/3D, 2D to 3D, 3D to 1D etc

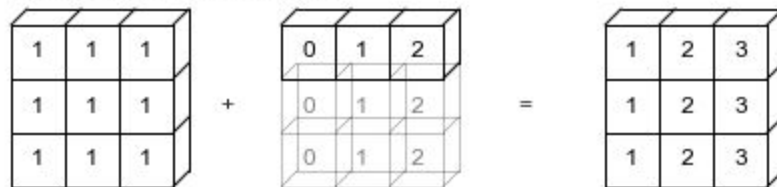
- Arithmetic
  - Element by element arithmetic for same shaped arrays
  - Broadcasting in case of dissimilar shapes (see next slide)
  - Dot multiplication, transpose
  - Trigonometric functions
  - Stat functions

# Broadcasting

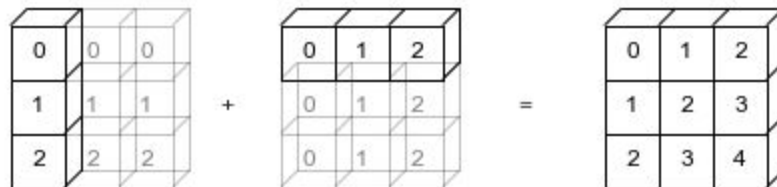
`np.arange(3)+5`



`np.ones((3,3))+np.arange(3)`



`np.arange(3).reshape((3,1))+np.arange(3)`



- Functions:
  - concatenate
  - stack
  - split, array\_split
  - where
  - sort
- Filtering

# Matplotlib

- Used for drawing charts and for general visualization
  - Inspired by MATLAB (lot of common terms like axis, plots etc)
- Most of the Matplotlib utilities lies under the pyplot submodule
  - You can import it via the matplotlib.pyplot namespace
  - Each pyplot function makes some change to a figure
    - E.g. create a plotting area, draw some lines, decorates the plot with labels etc



- Plot (specify marker, line characteristics)
- Multiple plots
- Labels, Title, Grid
- Subplots
- Different plots
  - Scatter, Bar, Pie
- Use of math functions
- Saving figures to a file

# References

- Numpy:  
<https://www.w3schools.com/python/numpy/default.asp>
- Matplotlib:  
[https://www.w3schools.com/python/matplotlib\\_pyplot.asp](https://www.w3schools.com/python/matplotlib_pyplot.asp)