Preliminaries

Deep learning - Spring 2020

Preliminaries
(Python, NumPy)

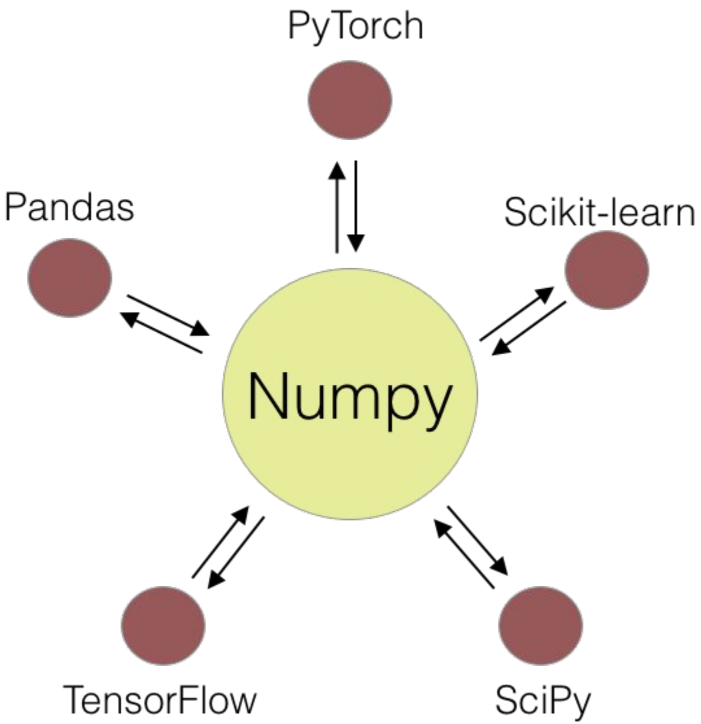
Why Python?

- Easy-to-use language
- Great community participation
- Decent library availability (especially machine learning libraries)

Numpy

- Core library for scientific computing in Python
- Appropriate for processing homogeneous multidimensional arrays and matrices

Numpy



Numpy

Array

- A numpy array is a grid of values, all of the <u>same type</u>
- number of dimensions is the *ndim (rank)* of the array
- The *shape* of an array is a tuple of integers giving the size of array along each dimension
- We can initialize numpy arrays from nested Python lists, and access elements using square brackets

Numpy

- Numpy is Fast
- Numpy arrays are densely packed arrays of homogeneous type (locality of reference)
- Many Numpy operations are implemented in C
- e.g. if you are summing up two arrays the addition will be performed with the specialized CPU vector operations

➢ [See the example of this part in the notebook]

Numpy

- Uses much less memory to store data (compared to Python lists)

```
np.array([1, 2, 3, 4], dtype=np.int8)
```

- Simple and beautiful API
- **Indexing**
- **Broadcasting**: Working with arrays of different shapes

➢ [See the examples for this part in the notebook]

Numpy

- Ex. Linear regression in Numpy

model $\longrightarrow$ $\boxed{h(x) = \sum_{i=0}^{d} \theta_i x_i = \theta^T x}$ loss $\longrightarrow$ $\boxed{J(\theta) = \frac{1}{2} \sum_{i=1}^{n} (h_\theta(x^{(i)}) - y^{(i)})^2}$

  - LMS algorithm

$$
\begin{aligned}
&\text{Repeat until convergence } \{ \\
&\qquad \theta_j := \theta_j + \alpha \textstyle\sum_{i=1}^{n} \left(y^{(i)} - h_\theta(x^{(i)})\right) x_j^{(i)} \qquad \text{(for every } j) \\
&\}
\end{aligned}
$$

  - The Normal Equation

$$X^T X\theta = X^T \vec{y} \quad \longrightarrow \quad \theta = (X^T X)^{-1} X^T \vec{y}$$

Links and references

- You can find a great tutorial about Python and Numpy here.
- Stanford CS229 lecture note about regression (and classification) is here.