Python

Deep Learning

Python

- open source software tools for developing deep neural networks are called frameworks.
- The two most popular frameworks are TensorFlow and PyTorch.
- Both frameworks are most commonly accessed through Python.
- Python is a high-level, interpreted, general-purpose programming language.
- We will cover the key Python concepts most used in deep learning.
- We also cover two important Python packages: NumPy and Pandas

Variables

- Variables are dynamically typed.
- Enter an integer, it is typed as an integer. Add a decimal it is typed as float.

```
a = 2
b = 3
c = a + b
print(c)
```

```
5
```

Dynamic typing

```
print(a/b)
```

```
0
```

```
d = 3.0
print(a/d)
```

```
0.6666666666666666
```

Lists

```
a = [2, 4, 6, 8]
print(a[0])
```

```
2
```

```
print(a[-1])  # neg. index cnts from right
```

```
8
```

```
a[1:3] = [] # remove elements 1 and 2
print(a)
```

```
[2, 8]
```

Tuples

```
a = 2, 4, 6, 8
print(a)
```

```
(2, 4, 6, 8)
```

```
print(a[0])
```

```
2
```

```
a[0] = 9
```

```
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
TypeError: 'tuple' object does not support
    ↪ item assignment
```

Dictionaries

```
dict = {'input': [1, 3, 7], 'target':[3,
    ↪ 7, 15]}
print(dict['input'])
```

```
[1, 3, 7]
```

```
print(dict.items())
```

```
[('input', [1, 3, 7]), ('target', [3, 7,
    ↪ 15])]
```

```
print(dict.keys())
```

```
['input', 'target']
```

If statement

```
x = -5
if x<0:
    y = -1
elif x>0:
    y = 1
else:
    y = 0
print(y)
```

```
-1
```

While loop

```
a = [1, 2, 3, 4]
i, x = 0, 0  #Multiple assignment
while i<len(a):
    x = x + a[i]
    i = i + 1

print(x)
```

```
10
```

For loop

```
x = 0
for num in a:
    x = x + num

print(x)
```

```
10
```

```
a = [’one’, ’two’, ’three’, ’four’]
for q in a:
    print(q)
```

```
one
two
three
four
```

For loop with list comprehension

```
a = [1, 2, 3, 4]
b = [x**2 for x in a]
print(b)
```

```
[1, 4, 9, 16]
```

Logical operators

```python
x, y = True, False
print(x and y)
print(x or y)
print(not x)
```

```
False
True
False
```

Functions

```
def f(y,q):
    return [y*y, 1/q]
```

```
zw = f(4.0,2.0)
print(zw)
```

```
[16.0, 0.5]
```

Iterators and generators

```
def bytwo(x):
    n = len(x)
    for i in range(0, n-1, 2):
        yield x[i:i+2]
```

```
a=[1, 2, 3, 4]
zz = bytwo(a)
for qq in zz:
    print(qq)
-----------------------------------------------
[1, 2]
[3, 4]
```

Modules

File Logic.py:

```
def a(x,y):
    print(x and y)

def o(x,y):
    print(x or y)
```

We can call this module's functions:

```
import logic
print(logic.a(True,False))
print(logic.o(True,False))
--------------------------------------------------------
False
True
```

Classes

```
class simplenet:
    def __init__(self,weight,bias):
        self.w = weight
        self.b = bias

    def sim(self,p):
        return self.w*p + self.b
```

```
net = simplenet(4.0,2.0)
print(net.sim(3.0))
------------------------------------------------
14.0
```

NumPy

- NumPy is a module for scientific computing (like MATLAB) in Python.
- It works well with the deep learning frameworks.
- The key object in NumPy is the multidimensional array (tensor).

NumPy arrays

```
import numpy as np
x = np.array([[1, 2, 3],[4, 5, 6]])
print(x)
print(x.ndim)
print(x.shape)
print(x.dtype)
```

```
[[1 2 3]
 [4 5 6]]
2
(2, 3)
int64
```

Array operations

```
a = np.arange(6)
print(a)
b = a.reshape(2,3)
print(b)
c = np.arange(0,12,2).reshape(2,3)
print(c)
d = np.arange(0,24,4).reshape(3,2)
print(d)
```

```
[0 1 2 3 4 5]
[[0 1 2]
 [3 4 5]]
[[ 0  2  4]
 [ 6  8 10]]
[[ 0  4]
 [ 8 12]
 [16 20]]
```

Multiplication

Hadamard multiplication

```
print(b*c)
```

```
[[ 0  2  8]
 [18 32 50]]
```

Standard matrix multiplication

```
print(np.matmul(c,d))
```

```
[[ 80 104]
 [224 320]]
```

Addition and broadcasting

```
e = np.arange(3)
print(e)
print(b+c)
print(b+e)
```

```
[0 1 2]
[[ 0  3  6]
 [ 9 12 15]]
[[0 2 4]
 [3 5 7]]
```

Indexing and slicing

```
print(b[1, 2])
print(b[0])
print(b[[0, 1],[1, 2]])
```

```
5
[0 1 2]
[1 5]
```

```
print(a[0:5:2])
print(a[:5])
print(a[-4:])
```

```
[0 2 4]
[0 1 2 3 4]
[2 3 4 5]
```

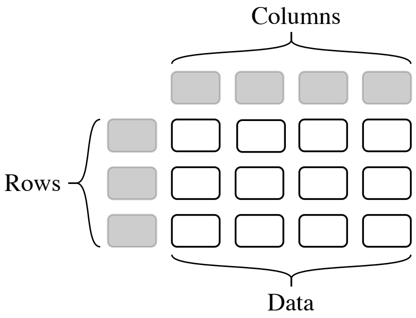
Sums and products across dimensions

```
print(np.sum(b))
print(np.sum(b,axis=0))
print(np.prod(b,axis=1))
```

```
15
[3 5 7]
[ 0 60]
```

Pandas

- Much deep learning workflow is devoted to data wrangling.
- This includes loading, formatting and preprocessing data.
- Pandas is a Python module for data wrangling.
- The main data structure of Pandas is DataFrame.



Panda can load many data types

- Comma-separated values (CSV)
- XLSX
- ZIP
- Plain Text (txt)
- JSON
- XML
- HTML
- HTML
- Images
- Hierarchical Data Format
- PDF
- DOCX
- MP3
- MP4
- SQL

Reading CSV file

```
import pandas as pd
sample_df = pd.read_csv('SampleDF.csv')
```

```
print(sample_df.shape)
-------------------------------------------
(100, 7)
```

```
print(sample_df.columns)
-------------------------------------------
Index(['Patient', 'Weeks', 'FVC', 'Percent
    ↪ ', 'Age', 'Sex', 'SmokingStatus'],
    ↪ dtype='object')
```

Dataframe description

```
print(sample_df.describe())
```

```
            Weeks          FVC     Percent        Age
count   100.00000   100.000000  100.000000 100.000000
mean     35.89000  2759.820000   78.187965  67.110000
std      24.90868   925.766484   21.094723   6.738844
min       0.00000   969.000000   43.352279  49.000000
25%      16.50000  2118.000000   62.821569  64.000000
50%      32.00000  2597.500000   73.989508  68.000000
75%      49.00000  3267.000000   89.005946  72.000000
max     116.00000  5768.000000  153.145378  87.000000
```

Dataframe info

```
sample_df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 100 entries, 0 to 99
Data columns (total 7 columns):
 #   Column         Non-Null Count  Dtype
---  ------         --------------  -----
 0   Patient        100 non-null    object
 1   Weeks          100 non-null    int64
 2   FVC            100 non-null    int64
 3   Percent        100 non-null
    ↪ float64
 4   Age            100 non-null    int64
 5   Sex            100 non-null    object
 6   SmokingStatus  100 non-null    object
dtypes: float64(1), int64(3), object(3)
memory usage: 5.6+ KB
```

Dataframe head

```
print(sample_df.head())
```

```
   Patient    Weeks   FVC    Percent   Age     Sex  \
0  ID00213     32   2972  81.828194   70    Male
1  ID00129      0   2253  59.622102   71    Male
2  ID00130     12   1648  68.116062   65  Female
3  ID00225     23    969  49.075715   77  Female
4  ID00082     33   2885  98.666211   49  Female

      SmokingStatus
0  Currently smokes
1      Never smoked
2      Never smoked
3      Never smoked
4  Currently smokes
```

Select a column (series)

```
fvc = sample_df['FVC']
fvc.describe()
```

```
count      100.000000
mean      2759.820000
std        925.766484
min        969.000000
25%       2118.000000
50%       2597.500000
75%       3267.000000
max       5768.000000
Name: FVC, dtype: float64
```

Select multiple columns or certain rows

```
twocol = sample_df[['Age', 'FVC']]
print(twocol.head())
```

```
   Age   FVC
0   70  2972
1   71  2253
2   65  1648
3   77   969
4   49  2885
```

```
older = sample_df[sample_df['Age']>75]
print(older.shape)
```

```
(8, 7)
```

Using loc and iloc

```
older_fvc = sample_df.loc[sample_df['Age'
    ↪ ]>75, ['Age', 'FVC']]
print(older_fvc.head())
```

```
     Age   FVC
3     77   969
7     83  3171
16    87  2220
59    77  1550
82    77  1818
```

```
sample_subset = sample_df.iloc[2:5, 1:3]
print(sample_subset.head())
```

```
   Weeks   FVC
2     12  1648
3     23   969
4     33  2885
```

Pivot

```
pivoted = sample_df.pivot(index='Patient', values = 'FVC', columns='
    ↪ Weeks')
print(pivoted.iloc[:5, :10])
```

```
Weeks      0    2    4    5    6    7       9   10      12      13
Patient
ID000116  NaN  NaN  NaN  NaN  NaN  NaN  3541.0  NaN     NaN  3410.0
ID000156  NaN  NaN  NaN  NaN  NaN  NaN     NaN  NaN     NaN     NaN
ID000206  NaN  NaN  NaN  NaN  NaN  NaN     NaN  NaN     NaN     NaN
ID000276  NaN  NaN  NaN  NaN  NaN  NaN     NaN  NaN  2472.0     NaN
ID000306  NaN  NaN  NaN  NaN  NaN  NaN     NaN  NaN     NaN     NaN
```

Melt

```
melted = sample_df.melt(id_vars='Patient',
    ↪ value_vars='Age')
print(melted.head())
```

```
                      Patient  variable  value
0  ID002136372022576929161 09       Age     70
1  ID001296372022198681880 00       Age     71
2  ID001306372022200594480 13       Age     65
3  ID002256372022593398376 03       Age     77
4  ID000826372022018362297 24       Age     49
```

Operations on Dataframes

```
print(older_fvc.apply(np.mean, axis=0))
```

```
Age        79.125
FVC      2284.500
dtype: float64
```

```
print(older_fvc.apply(lambda x: x.max() - x.min(),
    ↪ axis=0))
```

```
Age        11
FVC      3081
dtype: int64
```

```
print(older_fvc.min(axis=0))
```

```
Age       76
FVC      969
dtype: int64
```