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
```

```
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

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

```
False
True
False
```

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

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

```
[16.0, 0.5]
```

```
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]
```

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
```

```
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]]
```

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]
```

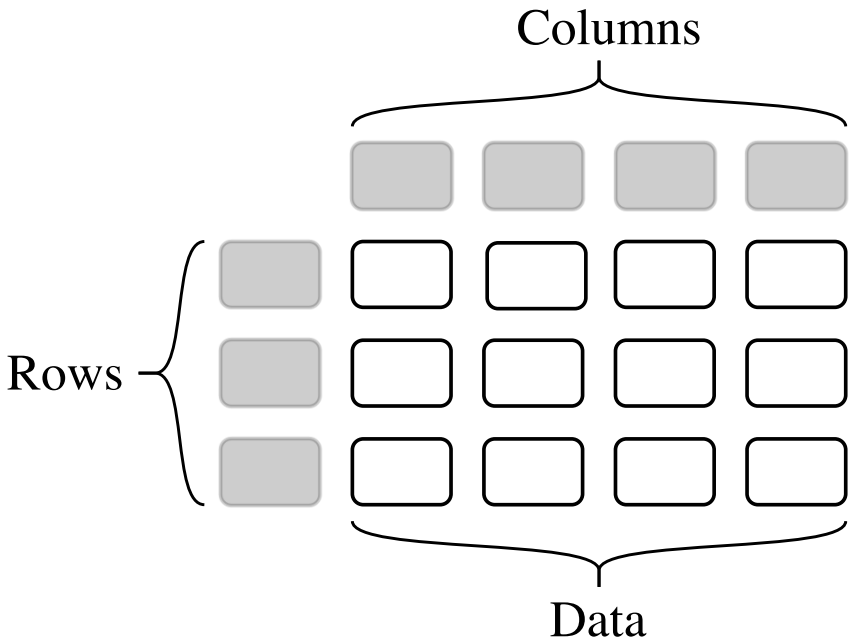
Sums and products across dimensions

```
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	ID00213637202257692916109	Age	70
1	ID00129637202219868188000	Age	71
2	ID00130637202220059448013	Age	65
3	ID00225637202259339837603	Age	77
4	ID00082637202201836229724	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
```