Authors: Wojciech Ptaś (7042843), Mhd Jawad Al Rahwanji (703890)

```
import numpy as np
import pandas as pd
try:
    from skmisc.loess import loess
except ImportError:
    from util import loess
import matplotlib.pyplot as plt
plt.rcParams['figure.figsize'] = [15, 10]
```

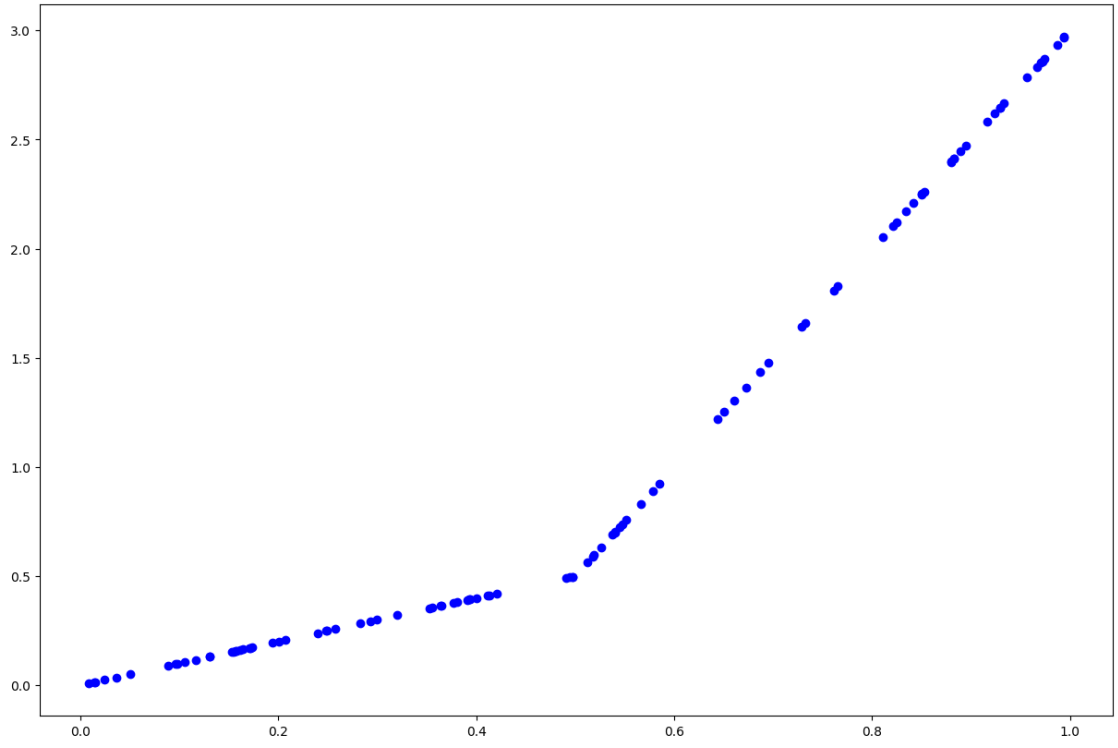
Now, we can load the data at data.csv and turn it into the predictor X and the target y

```
# X is contained in the first column of the data, y in the second.
data = pd.read_csv('data.csv',header=None)
X = data.iloc[:,0]
Y = data.iloc[:,1]
```

Create a scatterplot of the data.

```
plt.scatter(X,Y,c='b')
```

```
<matplotlib.collections.PathCollection at 0x23a499e1870>
```



Observations

The realtionship between two variables can be described as piecewise linear. Around $X = 0.5$ the rate of slope changes once.

We now define the kernels $K_1, \ldots, K_4$ as

```
def K1(x, x_):
    return 1

def K2(x, x_, lam):
    a=x-x_
    a=a/lam
    a=abs(a)
    a=a*a*a
    a=1-a
    b=a*a*a
    return b

def K3(x, x_, lam):
    return np.exp(-1*lam*(x-x_)*(x-x_))

def K4(x, x_, L):
    for i in range(1,L+1):
        if (i-1)/L <= x and x_ < i/L:
            return 1
    return 0
```

To write the function which takes X, y and a kernel K as input, we can do the following

```
def pred(X, y, K):
    from sklearn.metrics.pairwise import pairwise_kernels
    # Start by computing the matrix of all weights we'll need at once.
    X_=[[i] for i in X]
    #print(X_)
    matrix=pairwise_kernels(X=X_, metric=K)
    #print(matrix.shape)
    # Now, for each point we can compute the model using the
corresponding weights, and make a prediction.
    y_hat=[]
    for x in range(len(X)):
        model=loess(X,y,matrix[x])
        y_hat.append(model.predict(X[x]))
    # Return a vector of the predictions at each point in X.
    return y_hat
```

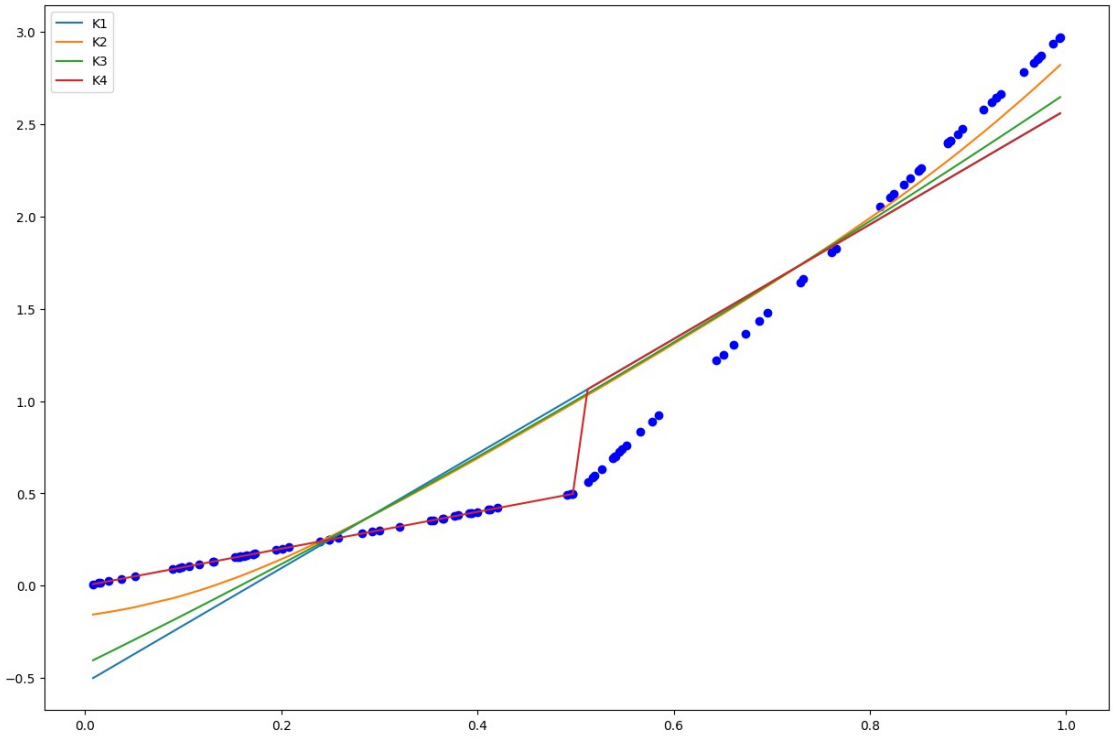
To actually use this function and show the fits of each kernel, we can iterate over all the kernels and fit the LOESS model for each of them.

```
from functools import partial # You may want to use this to make your
life easier.
plt.scatter(X, Y, c='b')
for kernel in [K1, K2, K3, K4]:
    if kernel == K1:
        plt.plot(X,pred(X,Y,kernel),label=kernel.__name__)
    elif kernel == K4:
```

```
        plt.plot(X,pred(X,Y,
partial(kernel,L=2)),label=kernel.__name__)
    else:
        plt.plot(X,pred(X,Y,
partial(kernel,lam=1)),label=kernel.__name__)


# Adding a legend so we know which kernel produced what is good style.
plt.legend()
```

```
<matplotlib.legend.Legend at 0x23a4c856d40>
```



We see...

Observations

First and third kernel yields similar results - straight line, which misses all the action. K4 catches the action, and yields the best results. K2 seems to smooth the endings a little, but misses the point when the data "breaks"