HW 6 notebook

November 19, 2017

In [19]:
```
import numpy as np
import matplotlib
import matplotlib.pyplot as plt

%matplotlib inline
```

In [20]:
```
x = np.array([0, 1.3, 2.1, 2.8, 4.2, 5.7])
y = np.array([-1, -1, -1, 1, -1, 1 ])
```

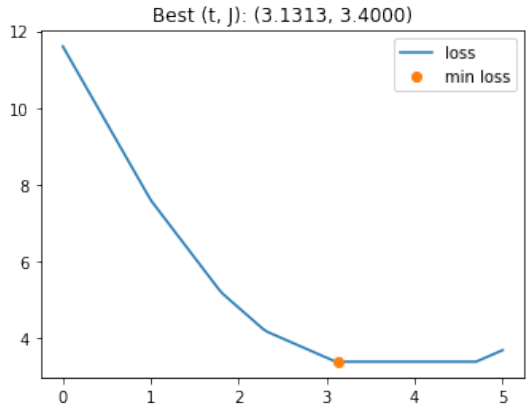
In [84]:
```
def predict(x, t):
    z = x-t
    return 1 if z > 0 else (-1 if z < 0 else float('NaN')) # 1 if z>0, -1 if z<0, break
    return res
```

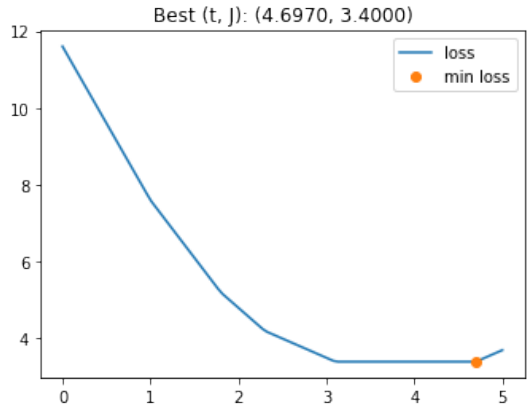
In [85]:
```
def hindgeLoss(x, y, t):
    z = x-t
    epsilon = np.maximum(0, 1 - y*z)
    return np.sum(epsilon)
```

0.0.1 Part 2 (a)

In [86]:
```
plt.figure(figsize=(12,4))
for i, cmp in enumerate([lambda a, b: a<b, lambda a, b: a<=b]):
    plt.subplot(1,2,i+1)
    hist = {}
    minLoss = float('Inf')
    t_best = -1
    hist['t'] = []
    hist['J'] = []

    for t in np.linspace(0, 5, 100):
        J = hindgeLoss(x, y, t)

        if cmp(J, minLoss):
            minLoss = J
            t_best = t

        hist['t'].append(t)
```

```
            hist['J'].append(J)

        plt.title("Best (t, J): ({:.4f}, {:.4f})".format(t_best, minLoss))
        plt.plot(hist['t'], hist['J'], label="loss")
        plt.plot(t_best, minLoss, 'o', label="min loss")
        plt.legend()
```





0.0.2 Part 2 (c)

```
In [111]: t = 4.5
          z = x-t
          epsilon = np.maximum(0, 1 - y*z)

          print(epsilon)
```

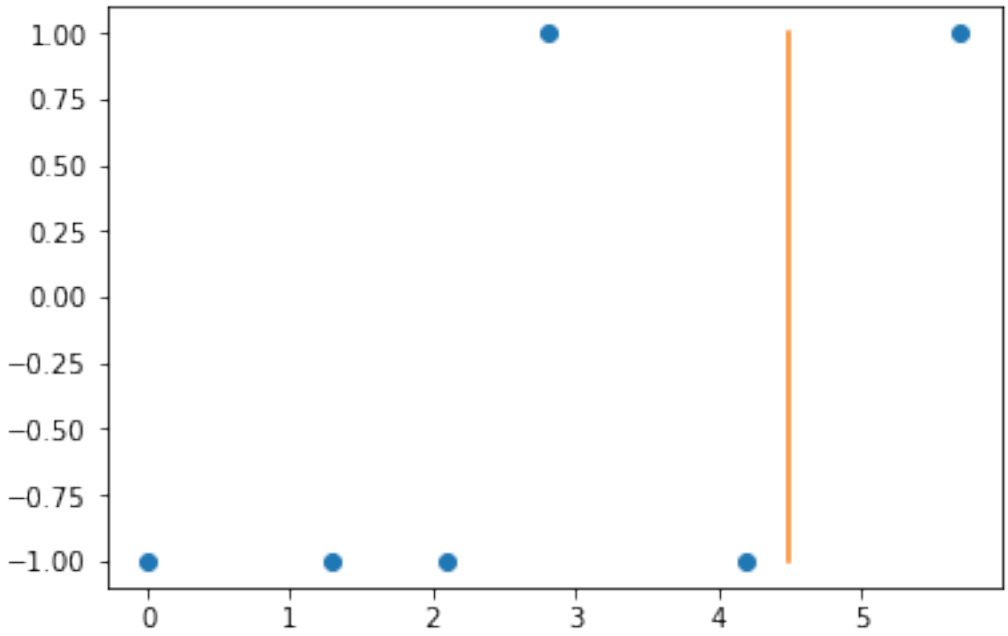
```
[ 0.   0.   0.   2.7  0.7  0. ]
```

0.0.3 Part 2 (d)

```
In [112]: def predict(x, t):
              z = x-t
              res = np.zeros_like(z)
              res[np.greater(z, 0)] = 1
              res[np.less(z, 0)] = -1
              res[np.equal(z, 0)] = float('NaN')
              return res
```

```
In [120]: plt.plot(x, y, 'o')
          plt.plot([t,t], [-1, 1])

          print(" x\ty\ty_hat\tcorrect\tslack")
          print("", *["{}\t{}\t{}\t{}\t{}\n".format(*u) for u in zip(x, y, predict(x, t), predic
```

```
x        y        y_hat        correct        slack
0.0        -1        -1.0        True        0.0
1.3        -1        -1.0        True        0.0
2.1        -1        -1.0        True        0.0
2.8        1        -1.0        False        2.7
4.2        -1        -1.0        True        0.7000000000000002
5.7        1        1.0        True        0.0
```




```
In [122]: print(" x & y & y_hat & correct & slack \\hline")
          print("", *["{} & {} & {} & {} & {} \\\\\n".format(*u) for u in zip(x, y, predict(x, t
```

```
 x & y & y_hat & correct & slack \hline
 0.0 & -1 & -1.0 & True & 0.0 \\
 1.3 & -1 & -1.0 & True & 0.0 \\
 2.1 & -1 & -1.0 & True & 0.0 \\
 2.8 & 1 & -1.0 & False & 2.7 \\
 4.2 & -1 & -1.0 & True & 0.7000000000000002 \\
 5.7 & 1 & 1.0 & True & 0.0 \\
```

0.0.4 Part 3 (a)

```
In [158]: X = [
            [0, 0, 0,  0],
```

```
 [0, 0, 1,  0],
 [0, 0, 1,  0],
 [0, 0, 1,  0]
]

W = [
 [0, 0, 0,  0],
 [0, 1, 1,  0],
 [0, 1, 1,  0],
 [0, 0, 0,  0]
]

X, W = np.array(X), np.array(W)


def vec(A):
    B = []
    [B.extend(A[:, i]) for i in range(A.shape[1])]
    return np.array(B)

x = vec(X)
w = vec(W)

print("X =",x)
print("W =",w)
print("x \\dot w =", np.dot(x, w))
```

```
X = [0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0]
W = [0 0 0 0 0 1 1 0 0 1 1 0 0 0 0 0]
x \dot w = 2
```

0.0.5 Part 3 (e)

```
In [159]: print(x.reshape(4,4, order='F'))
```

```
[[0 0 0 0]
 [0 0 1 0]
 [0 0 1 0]
 [0 0 1 0]]
```

0.0.6 Part 4 (a)

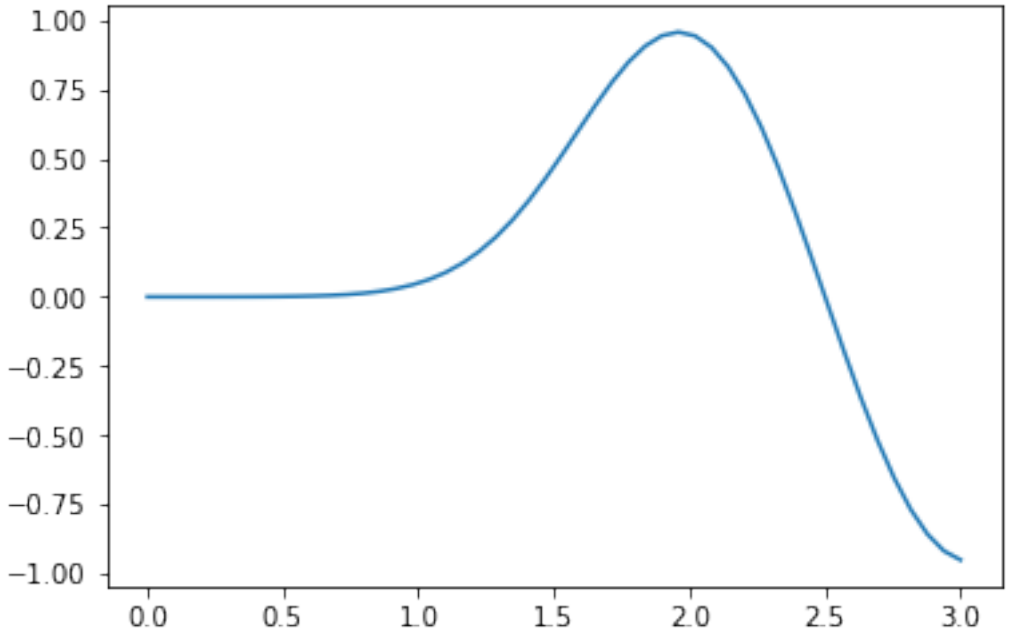
```
In [275]: # data
          x = np.array([0, 1, 2, 3])
          y = np.array([1, -1, 1, -1])

          # params
```

```
    alpha = np.array([0, 0, 1, 1]) # dual vector
    gamma = 3                      # param for rbf

    def rbf(a, b):
        return np.exp(-gamma * (a-b)**2)

    def predict(x, alpha, gamma, K):
        # data
        data_x = np.array([0, 1, 2, 3])
        data_y = np.array([1, -1, 1, -1])

        # score
        z = np.matmul(K(x, data_x), alpha*data_y)

        # prediction
        y_hat = np.zeros_like(z)
        y_hat[np.greater(z, 0)] = 1
        y_hat[np.less(z, 0)] = -1

        return y_hat
```

In [276]:
```
# data
data_x = np.array([0, 1, 2, 3])
data_y = np.array([1, -1, 1, -1])

# params
alpha = np.array([0, 0, 1, 1]) # dual vector
gamma = 3                      # param for rbf

# kernal function
def K(a, b):
    return np.exp(-gamma * (a-b)**2)

# points to classify
x = np.linspace(0,3)[:, None]

# interior score
z = np.matmul(K(x, data_x), alpha*data_y)

# prediction
y_hat = predict(data_x[:,None], alpha, gamma, K)

# accuracy
acc_a = np.mean(np.equal(y_hat, data_y))
print("\n\t{}% accuracy\n".format(100*acc_a))

# plot
plt.plot(x, z)
```

```
75.0% accuracy
```

Out[276]: [<matplotlib.lines.Line2D at 0x109eb5e48>]



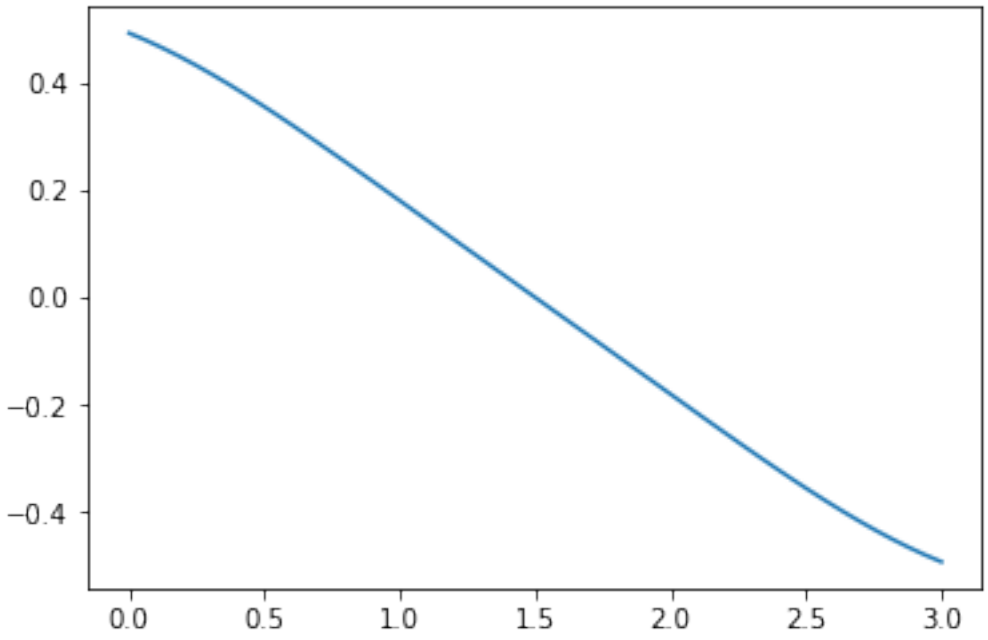
0.0.7 Part 4 (b)

In [277]:
```
# data
data_x = np.array([0, 1, 2, 3])
data_y = np.array([1, -1, 1, -1])

# params
alpha = np.array([1, 1, 1, 1]) # dual vector
gamma = 0.3                    # param for rbf

# kernal function
def K(a, b):
    return np.exp(-gamma * (a-b)**2)

# points to classify
x = np.linspace(0,3)[:, None]

# interior score
z = np.matmul(K(x, data_x), alpha*data_y)
```

```
    # prediction
    y_hat = predict(data_x[:,None], alpha, gamma, K)

    # accuracy
    acc_b = np.mean(np.equal(y_hat, data_y))
    print("\n\t{}% accuracy\n".format(100*acc_b))

    # plot
    plt.plot(x, z)
```

```
50.0% accuracy
```

```
Out[277]: [<matplotlib.lines.Line2D at 0x109fbceb8>]
```



0.0.8 Part 4 (c)

```
In [281]: print("\n\ta) {}% accuracy".format(100*acc_a))
          print("\tb) {}% accuracy\n".format(100*acc_b))
          print("\tThe settings in part (a) yield higher accuracy")
```

```
a) 75.0% accuracy
```

b) 50.0% accuracy

The settings in part (a) yield higher accuracy

In [ ]: