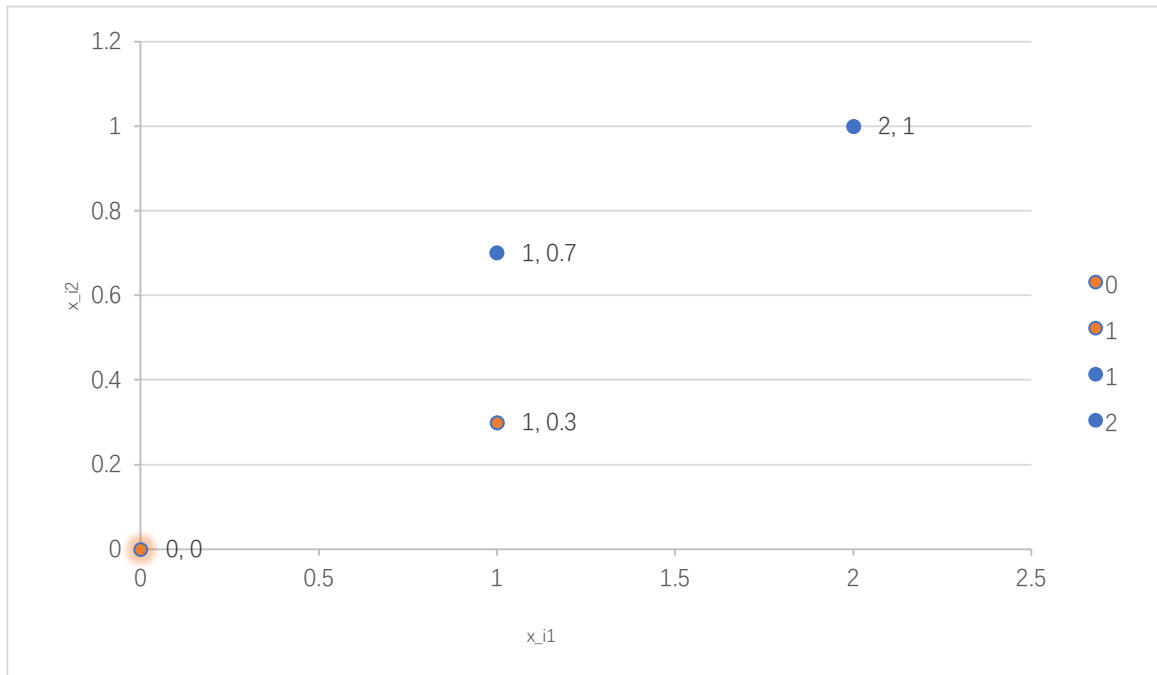


1. (a)



From this scatter plot, I choose the line $x_{i2} - 0.5 = 0$ to separate the two classes, so the intercept $b = 0.5$, $\omega_1 = 0$, $\omega_2 = 1$.

(b) $\gamma = 0.5$

(c) $\|\omega\| = 1$

$$m = \frac{\gamma}{\|\omega\|} = 0.5$$

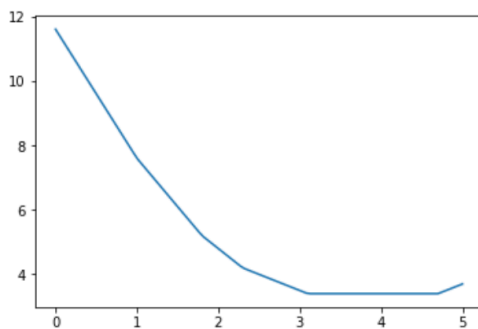
(d) (2,1) and (0,0) are on the margin

2.

(a)

```
t = np.linspace(0,5,100)
x = np.array([0,1.3,2.1,2.8,4.2,5.7])
y = np.array([-1,-1,-1,1,-1,1])
J = np.sum(np.where(1 - y * (x - t[:,None]) < 0, 0, 1 - y * (x - t[:,None])), axis = 1)
plt.plot(t, J)
```

[<matplotlib.lines.Line2D at 0x111b92780>]

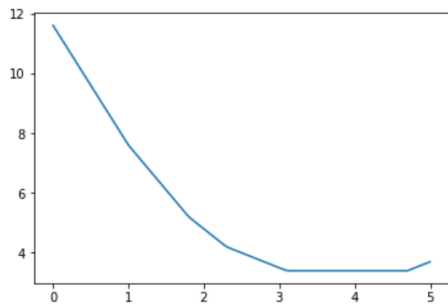


(b)

```
: t = np.linspace(0,5,100)
x = np.array([0,1.3,2.1,2.8,4.2,5.7])
y = np.array([-1,-1,-1,1,-1,1])
J = np.sum(np.where(1 - y *(x - t[:,None]) < 0, 0, 1 - y *(x - t[:,None])), axis = 1)
I = np.argmin(J)
t_min = t[I]
print(t_min)
print(np.where(1 - y *(x - t[:,None]) < 0, 0, 1 - y *(x - t[:,None]))[I,:])
plt.plot(t, J)
```

```
3.131313131313131
[0.          0.          0.          1.33131313  2.06868687  0.          ]
```

```
: [<matplotlib.lines.Line2D at 0x111edb160>]
```



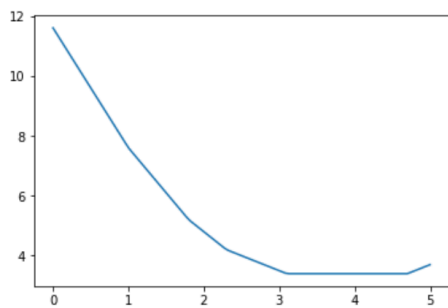
$t = 3.131313$

(c)

```
: t = np.linspace(0,5,100)
x = np.array([0,1.3,2.1,2.8,4.2,5.7])
y = np.array([-1,-1,-1,1,-1,1])
J = np.sum(np.where(1 - y *(x - t[:,None]) < 0, 0, 1 - y *(x - t[:,None])), axis = 1)
I = np.argmin(J)
t_min = t[I]
print(t_min)
print(np.where(1 - y *(x - t[:,None]) < 0, 0, 1 - y *(x - t[:,None]))[I,:])
plt.plot(t, J)
```

```
3.131313131313131
[0.          0.          0.          1.33131313  2.06868687  0.          ]
```

```
: [<matplotlib.lines.Line2D at 0x111edb160>]
```



$\epsilon_i = [0 \ 0 \ 0 \ 1.33131313 \ 2.06868687 \ 0]$

(d)

sample (2.8, 1) (4.2, -1) is violate the margin , these two samples are also misclassified.

3.

(a) $x = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 0\ 0]$

$w = [0\ 0\ 0\ 0\ 0\ 1\ 1\ 0\ 0\ 1\ 1\ 0\ 0\ 0\ 0\ 0]$

(b) $z = 2$

(c) $x_{\text{right}} = [0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 1\ 1\ 1]$

$z = 0$

(d) $x_{\text{left}} = [0\ 0\ 0\ 0\ 0\ 1\ 1\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 0\ 0]$

$z = 2$

(e) $x = \text{Xmat.ravel()}$

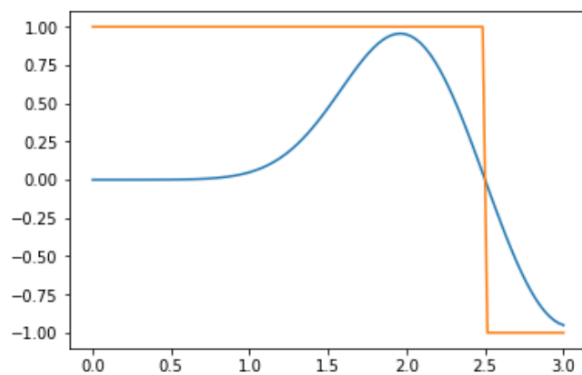
$\text{Xmat} = x.\text{reshape}((4,4))$

4.

(1)

```
alpha = np.array([0,0,1,1])
gamma = 3
xts = np.linspace(0,3, 100)
xtr = np.array([0,1,2,3])
ytr = np.array([1,-1,1,-1])
# print(xts[:,None])
k = np.exp(-gamma * (xtr - xts[:,None])**2)
z = np.sum(alpha * k * ytr, axis = 1)
yhat = np.where(z > 0, 1, -1)
plt.plot(xts, z)
plt.plot(xts, yhat)
```

[<matplotlib.lines.Line2D at 0x1167c7128>]



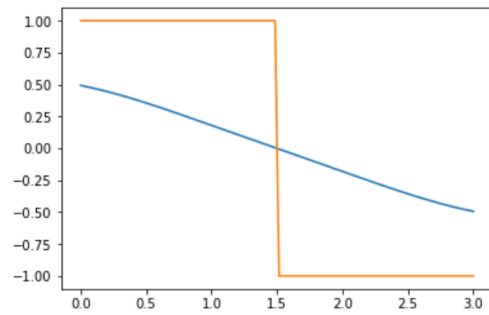
(b)

```

]: alpha = np.array([1,1,1])
   gamma = 0.3
   xts = np.linspace(0,3, 100)
   xtr = np.array([0,1,2,3])
   ytr = np.array([1,-1,1,-1])
   # print(xts[:,None])
   k = np.exp(-gamma * (xtr - xts[:,None])**2)
   z = np.sum(alpha * k * ytr, axis = 1)
   yhat = np.where(z > 0, 1, -1)
   plt.plot(xts, z)
   plt.plot(xts, yhat)

```

```
]: [<matplotlib.lines.Line2D at 0x116b92400>]
```



(c)

The second classifier makes more errors.