Course: Machine Learning Techniques
Practice Questions
Week 8

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1. (1 point) (Multiple select) In hard margin SVM, maximizing $\frac{2}{||w||}$ is equivalent to

   A. Maximizing $\frac{||w||}{2}$

   B. Minimizing $||w||$

   C. Minimizing $||w||^2$

   D. Maximizing $||w||^2$

   Answer: B,C

2. (1 point) (Multiple select) Which of the following are true statements for SVM:

   A. The hyper plane changes if any one of the support vector points is removed from dataset.

   B. The hyper plane remains same if any one of the support vector points is removed from dataset.

   C. The hyper plane changes if new data points are added in dataset. These new points are not candidates for support vectors.

   D. The hyper plane remains the same if new data points are added in dataset. These new points are not candidates for support vectors.

   Answer: A,D

3. (1 point) Suppose we have eight data points along with their labels as shown in the table. Plot these data points and identify the support vectors.

Index	Data Points	Labels
a	(2,1)	-1
b	(2,-1)	-1
c	(0,2)	-1
d	(4,0)	1
e	(5,1)	1
f	(6,2)	1
g	(-1,0)	-1
h	(5,-1)	1

   A. a,b,d

   B. a,b,e

   C. b,c,d

D. c,d,g

E. c,g,h

F. b,e,h

Answer: B

Solution:

By looking at the data, the support vectors are-

$S_1 = (2, 1), S_2 = (2, -1), S_3 = (4, 0)$

4. (1 point) Consider the following data set and the labels.

Data Points	Labels
(3,1)	1
(3,-1)	1
(6,1)	1
(6,-1)	1
(1,0)	-1
(0,1)	-1
(0,-1)	-1
(-1,0)	-1

A. w=(1,0) and b=-2

B. w=(1,1) and b=-4

C. w=(2,2) and b=2

D. w=(2,1) and b=1

Answer: A

Solution: Using SVM algorithm, find the weight w and bias b for the hyper-plane.

Solution:

By looking at the data, the support vectors are-

$S_1 = (1, 0), S_2 = (3, 1), S_3 = (3, -1)$

For vector representation we have to add augmented bias

$\tilde{s}_1 = (1, 0, 1)$ $\tilde{s}_2 = (3, 1, 1)$ $\tilde{s}_3 = (3, -1, 1)$

Now we have to solve the following system of equation:

$$\alpha_1 \tilde{s}_1.\tilde{s}_1 + \alpha_2 \tilde{s}_1.\tilde{s}_2 + \alpha_3 \tilde{s}_1.\tilde{s}_3 = -1 \tag{1}$$

$$\alpha_1 \tilde{s}_2.\tilde{s}_1 + \alpha_2 \tilde{s}_2.\tilde{s}_2 + \alpha_3 \tilde{s}_2.\tilde{s}_3 = 1 \tag{2}$$

$$\alpha_1 \tilde{s}_3.\tilde{s}_1 + \alpha_2 \tilde{s}_3.\tilde{s}_2 + \alpha_3 \tilde{s}_3.\tilde{s}_3 = 1 \tag{3}$$

We will get,

$\alpha_1 = -3.5\alpha_2 = 0.75\alpha_3 = 0.75$

Hence W=$\sum \alpha_i \tilde{s}_i = (1, 0, -2)w = (1, 0)andb = -2$

(Common data Q4, Q5) Use Lagrange Multipliers to find the global maximum and minimum values of $f(x, y) = x^2 + 2y^2 - 4y$

subject to the constraint

x$^2 + y^2 = 9$.

5. (1 point) What is the global maximum value?

   Answer: 30

6. (1 point) What is the global minimum value?

   Answer: 5

   Solution

   $g(x, y) = x^2 + y^2$

   Then solving the equation

   $\Delta f(x, y) = \lambda \Delta g(x, y)$ along with the constraint, we get the following system of equation-

   $2x = \lambda 2y$

   4y-4=$\lambda 2y$

   x$^2 + y^2 = 9$

   Solving (1) we get 2 solution x=0 or $\lambda = 1$

   For x=0, y= ± 3

   For $\lambda = 1$

   y=2 and x=$\pm\sqrt{5}$

   Now evaluating the function at these 4 points we find that,

   the global maximum is 30, which occurs at (0, 3), and the global minimum is 5, which occurs at the two points $(\pm\sqrt{5}, 2)$.

7. (1 point) Let K(x,y) and K'(x,y) be kernels then K+K' is also a kernal.

   A. True

   B. False

   Answer: A

8. (1 point) Let $f : \mathbb{R} \to \mathbb{R}^3$ be defined by

   $f(x) = (1, \sqrt{2}x, x^2)$

   Which of the following will be the most suitable kernel to find $< f(x), f(y) >$.

   A. $K(x, y) = (< x, y >)^2$

   B. $K(x, y) = (1+ < x, y >)^2$

   C. $K(x, y) = (< x, y > -1)^2$

   D. $K(x, y) = (< x, y > + < y, x >)$

   Answer: B

9. (1 point) Let $K(x, y) = fK'(x, y)$ where $f > 0$. Let ϕ and ϕ' be the feature composition corresponding to K and K' respectively such that $\phi(x) = g\phi'(x)$ then $g =$

   A. f

   B. $\sqrt{f}$

   C. f^2

   Answer: B

10. (1 point) Let $f : \mathbb{R}^3 \to \mathbb{R}^9$ be defined by

    $f(x_1, x_2, x_3) = (x_1x_1, x_1x_2, x_1x_3, x_2x_1, x_2x_2, x_2x_3, x_3x_1, x_3x_2, x_3x_3)$

    Which of the following will be the most suitable kernel to find $< f(x), f(y) >$.

    A. $K(x, y) = (< x, y >)^2$

    B. $K(x, y) = (1+ < x, y >)^2$

    C. $K(x, y) = (< x, y > -1)^2$

    D. $K(x, y) = (< x, y > + < y, x >)$

    Answer: A

11. (1 point) (Multiple select) Consider the following data set and the labels.

Data Points	Labels
(2,0)	1
(0,2)	1
(-2,0)	1
(0,-2)	1
(1,1)	-1
(1,-1)	-1
(-1,1)	-1
(-1,-1)	-1

Since the data-points are not linearly seperable, use the following transformation to identify which of the following are support vectors in the new space.

$$f(x_1, x_2) = \begin{cases} (6 - x_1 + (x_1 - x_2)^2, 6 - x_2 + (x_1 - x_2)^2), & \sqrt{x_1{}^2 + x_2{}^2} \geq 2 \\ (x_1, x_2), & \text{otherwise} \end{cases}$$

A. (8,10)

B. (10,8)

C. (12,10)

D. (1,1)

Answer: A,B,D

Solution:

After transformation, the new points will be

Data Points	Labels
(8,10)	1
(10,8)	1
(12,10)	1
(10,12)	1
(1,1)	-1
(1,-1)	-1
(-1,1)	-1
(-1,-1)	-1

Plotting the points will reveal that A, B and D are the support vectors.

12. (1 point) ________ are sometimes used when classifying text documents or DNA sequences.

A. Exponential Trick

B. RBF kernel

C. String kernel

D. Linear kernel

Answer: C