

# Intelligent Systems: Reasoning and Recognition

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ENSIMAG 2

Winter Semester 2018

Exercise 5

14 March 2018

## Support Vector Machines with Radial Basis Functions

A radial basis function (RBF) is a real-valued function whose value depends only on the distance from the origin. The Gaussian function

$$f(\|\vec{x} - \vec{c}\|) = e^{-\frac{\|\vec{x} - \vec{c}\|^2}{2}}$$

is a popular Radial Basis Function, and is often used as a kernel for support vector machines. When used in this way, each center point,  $\vec{c}$ , is one of the support vectors.

We can use a sum of N radial basis functions to define a discriminant function, where the support vectors are drawn from the M training samples. This gives a discriminant function

$$g(\vec{X}, \vec{w}) = \sum_{m=1}^M a_m y_m f(\|\vec{X} - \vec{X}_m\|) + w_0,$$

The training samples  $\vec{X}_m$  for which  $a_m \neq 0$  are the support vectors.

Suppose that you have two classes and a training data composed of 10 samples,  $\{\vec{X}_m\} \{y_m\}$  and that an SVM learning algorithm has provided the weights  $\{a_m\}$  as shown below, with  $b=0$ .

- Write out the polynomial for the discriminant function  $g(\vec{X}, \vec{w})$
- Is the training data separable with this discriminant function?

m	y	x <sub>1</sub>	x <sub>2</sub>	a <sub>m</sub>
1	1	1	1	0
2	1	1	3	0
3	1	2	2	1
4	1	3	1	0
5	1	3	3	0
6	-1	1	5	0
7	-1	3	5	1
8	-1	5	1	0
9	-1	5	3	1
10	-1	5	5	0