# XOR Classification Problem

The exclusive-or problem is a simple, but nonlinear classification problem. The problem is to design an algorithm, or function that produces the value True with input (True, False) or (False, True). The algorithm should produce False when the input is (True, True) or (False, False).

Letting 0 represent False and 1 represent True. Then graphically the XOR problem.

|  |  |  |
| --- | --- | --- |
|  | 0 | 1 |
| 0 | 0 | 1 |
| 1 | 1 | 0 |

The inputs to the XOR problem are in red and the outputs are in blue.

This problem is nonlinear because there is not a single straight line that you can draw that separates the outputs into the two classes, 0 and 1.

An example of a linear problem is the OR problem, which graphically looks like

|  |  |  |
| --- | --- | --- |
|  | 0 | 1 |
| 0 | 0 | 1 |
| 1 | 1 | 1 |

For this problem you could draw a straight line sloping upward to the right that separates the output 0 value from output 1 values. The logical AND problem is similarly linear.

## Learning the XOR Problem using Support Vector Machines (SVM)

First, install the e1071 package. Then set up the XOR problem as follows.

1. Create a 4,2 array with the input values

* x <- array(data = c(0,0,1,1,1,0,0,1),dim=c(4,2))

For example

> x <- array(data = c(0,0,1,1,0,1,0,1),dim=c(4,2))

> x

[,1] [,2]

[1,] 0 0

[2,] 0 1

[3,] 1 0

[4,] 1 1

1. Next create a vector of factors (outputs for the input values

* y <- factor(c(0,1,1,0))

For example

> y <- factor(c(0,1,1,0))

> y

[1] 0 1 1 0

Levels: 0 1

1. Next, create the SVM model

* model <- svm(x,y,type="C-classification")

1. To display some information about the created model you can enter these two commands
   * summary(model)
   * print(model)
2. To see the SVM model predictions for the input values enter the following
   * predict(model,x)

* You should see a list of the four x inputs along with the predicted values.

Now that you have seen how to put together a simple learning problem see if you can extend the ideas to other examples.