Support Vector Machines

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EXERCISE 1. SUPPORT VECTOR MACHINES

We consider the following classification problem in the real plane $\mathbb{R}^2$:

x_1	0	1	2	1	0	1
x_2	0	2	1	1	1	0
Class	-1	-1	-1	1	1	1

1. Prove that those two classes are not linearly separable.
2. Write the formula that describes the decision function of a linear Support Vector Machine classifier. Explain how it is used to assign a new point (x_1,x_2) to one of the two classes.
3. Propose a feature vector $\phi(x_1,x_2)$ so that the previous classification problem is linearly separable in the feature space. What is the kernel in this feature space ? Write down the decision function for this SVM.

EXERCISE 2. SVM QUIZ

Tell for each of the following statements if **True** or **False** (here, motivation is not required):

1. If the data is not linearly separable, then there is no solution to the hard-margin SVM.
2. In soft-margin SVM, increasing the value of the C hyper-parameter increases the width of the margin.
3. The kernel trick allows to extend linear classifiers to non-linear decision boundaries.
4. In soft-margin SVM, the values of α_i for support vectors are 0.
5. In SVMs, the sum of the Lagrange multipliers corresponding to the positive examples is equal to the sum of the Lagrange multipliers corresponding to the negative examples.
6. In hard-margin SVM, we maximize $\frac{1}{2}\|w\|^2$ subject to the margin constraints.
7. The C hyper-parameter of soft-margin SVM should be tuned on the test data.
8. We should train a hard-margin SVM several times from different random starting points to reduce the risk of being trapped in a bad local minimum.