Submission Date: 26th November 2021

1 Support Vector Machines

1. Explain the "kernel trick" and why we use it in SVMs.

2. What is the difference between hard- and soft-margin SVM?

2 Linear Separability

Given is the following dataset:

x	y
-3	-1
-2	-1
-1	-1
0	1
1	1
2	-1
3	-1

1. Create a sketch of the data. Is it linearly separable? If so, draw a separating hyperplane.

2. Apply the mapping $g : \mathbb{R} \to \mathbb{R}^2$ defined by:

$$g(x) = \begin{pmatrix} x \\ x^2 \end{pmatrix} \tag{1}$$

   on all the data points to create the transformed data set and create a plot of it. Is the transformed data set linearly separable? If yes, find a separating hyperplane $< \mathbf{w}, \mathbf{x} > +b = 0$, compute its parameters[1] and plot it.

3. Use the computed hyperplane from 2. and compute its output for $x = \frac{1+\sqrt{5}}{2}$. Does it belong to the positive or negative class and why?

3 Soft-Margins and Regression in SVM

1. How is the objective function modified in SVM to account for soft-margins? Which hyperparameter controls the strength of this regularization?

2. How could be the loss modified to perform regression?

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[1]It is fine if you use the border points only, i.e. only active constraints