3. Kernels

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Homework due Mar 8, 2023 08:59 -03 Completed

In this question, we will practice kernel methods in classification.

3. (a)

0.6666666666666666/1 point (graded)

Let $\boldsymbol{x}, \boldsymbol{q} \in \mathbb{R}^2$ be two feature vectors, and let $\boldsymbol{K}(\boldsymbol{x}, \boldsymbol{q}) = (\boldsymbol{x}^T \boldsymbol{q} + \mathbf{1})^2$. This is often known as a polynomial kernel. It's simple to compute: you just take the dot product between two feature vectors, add one, and then square the result. But what kind of feature mapping does this kernel implicitly use?

Assuming we can write $\boldsymbol{K}(\boldsymbol{x}, \boldsymbol{q}) = \boldsymbol{\phi}(\boldsymbol{x})^T \boldsymbol{\phi}(\boldsymbol{q})$, derive an expression for $\boldsymbol{\phi}(\boldsymbol{x})$.

Enter the solution as a vector $\boldsymbol{\phi}(\boldsymbol{x}) = [\boldsymbol{f}_1(\boldsymbol{x}_1, \boldsymbol{x}_2), \cdots, \boldsymbol{f}_N(\boldsymbol{x}_1, \boldsymbol{x}_2)]$.

$\boldsymbol{\phi}(\boldsymbol{x}) =$ [x_1^2, sqrt(2)*x_1*x_2, x_2^2, 1] ✱

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3. (b)

0/1 point (graded)

As a simple example that uses this kernel, imagine that our feature vectors were bag of words vectors in $\mathbb{R}^{|V|}$ where $|V|$ is the vocabulary size. In this example, give an intuitive interpretation of what the $\sqrt{2}\boldsymbol{x}_1\boldsymbol{x}_2$ term in the expression for $\boldsymbol{\phi}(\boldsymbol{x})$ you just wrote down means.

- (●) consecutive co-appearance (bigram)
- ( ) co-appeareance in document

✖

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- ? 3b) clearance on the interaction term? — are the question strictly refer to x1*x2 or I should think in a more general case and the trust must still hold? for example, if ... — 4
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- What do "consecutive co-appearance (bigram)" and "co-appeareance in document" mean? — 7

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