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6. Kernel Composition Rules

Kernel Composition Rules

0:00 / 0:00 1.50x

Video

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Kernel Composition Rules 1

1/1 point (graded)

Recall from the video above that if $f : \mathbb{R}^d \to \mathbb{R}$ and $K\left(x, x'\right)$ is a kernel, so is

$$\widetilde{K}\left(x, x'\right) = f\left(x\right) K\left(x, x'\right) f\left(x'\right).$$

If there exists $\phi\left(x\right)$ such that

$$K\left(x, x'\right) = \phi\left(x\right) \cdot \phi\left(x'\right),$$

then which of the following φ gives

$$\widetilde{K}\left(x, x'\right) = \varphi\left(x\right) \cdot \varphi\left(x'\right)?$$

- ○ $\varphi\left(x\right) = f\left(x\right) K\left(x, x\right)$
- ○ $\varphi\left(x\right) = f\left(x\right) K\left(x, x'\right)$
- ○ $\varphi\left(x\right) = f\left(x\right)$
- ● $\varphi\left(x\right) = f\left(x\right) \phi\left(x\right)$

✔

Solution:

As $f(x), f(x') \in \mathbb{R},$ we have $(f(x)\phi(x)) \cdot (f(x')\phi(x')) = \widetilde{K}(x, x').$
Hence $\varphi(x) = f(x)\phi(x)$ gives $\widetilde{K}(x, x') = \varphi(x) \cdot \varphi(x').$

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You have used 1 of 2 attempts

Answers are displayed within the problem

Kernel Composition Rules 2

1/1 point (graded)

Let x and x' be two vectors of the same dimension. Use the the definition of kernels and the kernel composition rules from the video above to decide which of the following are kernels. (Note that you can use feature vectors $\phi(x)$ that are not polynomial.)

(Choose all those apply.)

- [x] 1
- [x] $x \cdot x'$
- [x] $1 + x \cdot x'$
- [x] $(1 + x \cdot x')^2$
- [x] $\exp(x + x')$, for x,$x' \in \mathbb{R}$
- [ ] $\min(x, x')$, for x,$x' \in \mathbb{Z}$

Solution:

We go through the choices in order:

- Yes, for $\phi(x) = 1$.
- Yes, for $\phi(x) = x$.
- Yes, since the sum of kernels are kernels. In this case, we can also easily see $\phi(x) = [1, x]^T$ works.
- Yes, since the product of kernels are kernels. (In this case, factoring the kernel as dot products are more involved, and the composition rule saves this work.)
- Yes, for $\phi(x) = \exp(x)$.
- No. For example, $\min(-1, -1) = -1 < 0$ and hence cannot be written as a dot product and is not a valid kernel.

Submit You have used 2 of 3 attempts

Answers are displayed within the problem

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[Staff] What does exp(x+x') mean when x is a vector 5
I don't understand what exp(x+x') means when x is a vector. For example, if x=x'=[1,1], exp(x+...

Question regarding explanation to the answer of last question 4

What is the resulting transformation when you multiply kernels? 2
He skipped that in the discussion. If you have two kernels and add the, it's equivalent to a tra...

? Handwriting is difficult to understand
Is it possible to release handout in this part or have the black board writing to make all hand... 2

? I don't understand anything in this page.
Not sure if it's just a brain freeze or it's an unknown knowledge gap that blocks me from und... 2

Inner product notation 2

? [STAFF] x and x_prime
On 0:24 of the video, lecturer says: "Simple constant one is a kernel function. The **correspo... 2

Interesting material
I found this interesting about kernel algebra.. it may help! https://people.cs.umass.edu/~dom... 1

6.6 Segment notes
Community TA 2

[staff]: Integral kernel 5

? Definition of kernel
In the video I found the definition of kernel rules (kernel algebra?) but what is exactly a kernel? 10

quite challenging
after watching these videos I'm always like "should I be like Warren and just push through be... 4

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