

### Shakil Rafi: Reading Assignment 6

1. While a Hilbert space is a real or complex vector equipped with a norm induced from an inner product under which it is a complete metric space, a reproducing Hilbert space is one in which the evaluation operator  $L_x : f \rightarrow f(x)$  is a bounded operator. I honestly can't think of a counterexample, i.e. a Hilbert space that is not reproducing.
2. *Shattering* is an amazing description. Given the intersection of a set collection  $\mathcal{H}$  and a set  $C$ ,  $\mathcal{H}$  shatters  $C$  if  $\mathcal{H} \cap C$  contains all the subsets of  $C$ , i.e.  $|\mathcal{H} \cap C| = 2^{|C|}$ . The Vapnik-Chervonik dimension of  $\mathcal{H}$  is the largest of a set such that it is shattered by  $\mathcal{H}$ .
3. The inner product of vectors  $u$  and  $v$  is  $\langle u, v \rangle = u^T v$ .
4. SVM arises because we might need non-linear decision boundaries and we don't want to deal with an enlarged feature space.
5. While the linear SVC can be represented as  $f(x) = \beta_0 + \sum_{i=1}^n \alpha_i \langle x, x_i \rangle$ , using kernels we aim to represent different SVMs as  $f(x) = \beta_0 + \sum_{i \in \mathcal{S}} \alpha_i K(x, x_i)$  where the different kernels  $K(x, x_i)$  are as follows.
6. An SVC is an SVM which uses the linear kernel,  $K(x_i, x'_i) = \sum_{j=1}^p x_{ij} x'_{ij}$
7. A polynomial kernel of degree  $d$  is one where the kernel has the form  $K(x_i, x_{i'}) = (1 + \sum_{j=1}^p x_{ij} x'_{ij})^d$ .
8. A radial kernel has the form  $K(x_i, x_{i'}) = \exp(-\gamma \sum_{j=1}^p (x_{ij} - x'_{ij})^2)$ .
9. Kernels are necessary because they simplify calculations, instead of calculating using an enlarged feature space.
10. SVM's can be generalized to have more than two classes.