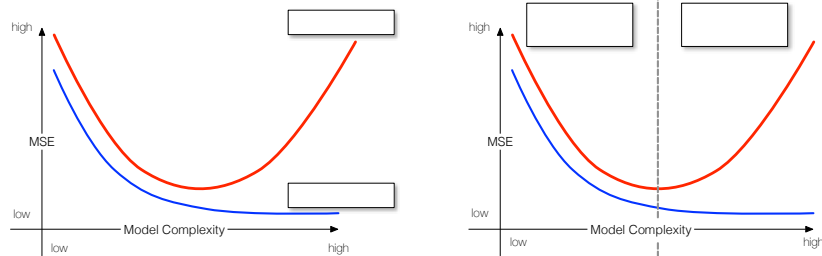# 2413, Machine Learning, Tutorial 6
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Bias/Variance

1. The two graphs below show train and test-error of some model as a function of the model complexity. In the left graph, indicate which of the two curves shows the 'training error' or 'test error'. In the right graph, indicate which regions show 'high variance' or 'high bias'.

VC Dimension

2. Give the VC-dimension for the following 2D-hypothesis spaces for binary classification:

   - The set of origin-centered circles in the plane (+1 inside and -1 outside the circle).

   - The set of all circles in the plane (+1 inside and -1 outside the circle).

3. Consider the class $\mathcal{H}^d$ of linear classifiers in $\mathcal{R}^d$. Each classifier in this class is parametrized by a vector $w \in \mathcal{R}^d$ and has the form:

$$h_w(x) = \begin{cases} 1 & \text{if } w^T x > 0 \\ -1 & \text{otherwise} \end{cases} \tag{1}$$

Note that we do not allow a bias term w_0, and thus the separating hyperplanes must pass through the origin.

Show that there is a set of d points in $\mathcal{R}^d$ that can be shattered by $\mathcal{H}^d$.