भारतीय प्रौद्योगिकी संस्थान तिरुपति
IIT TIRUPATI

Deep Learning

2.2 Over and Under fitting

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Generalization

1. Ability of an ML model to perform on unseen data

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1. Ability of an ML model to perform on unseen data
2. Goal of good ML model is to generalize well from training data to any data from the task domain

Fit

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3. In ML we don't know the target function under approximation

Over and under fitting

1. Cause of poor performance in ML is either overfitting or underfitting to the data

Overfitting

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2. Model learns the noise and random fluctuations in the data as concepts (to an extent that affects its generalization)
3. More likely to occur in case of nonparametric and nonlinear models with more flexibility

Example

1. Decision trees are a nonparametric model

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2. Flexible and prone to overfitting training data

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1. Decision trees are a nonparametric model
2. Flexible and prone to overfitting training data
3. Can be addressed by pruning the tree after learning (removes some of the detail picked up)

Underfitting

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3. Can be alleviated by trying alternate ML algorithms (e.g. relatively complex)

Good fit in ML

1. Ideally, one should select a model at the sweet spot between over and underfitting

Good fit in ML

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1. Ideally, one should select a model at the sweet spot between over and underfitting
2. Very difficult in practice

Good fit in ML

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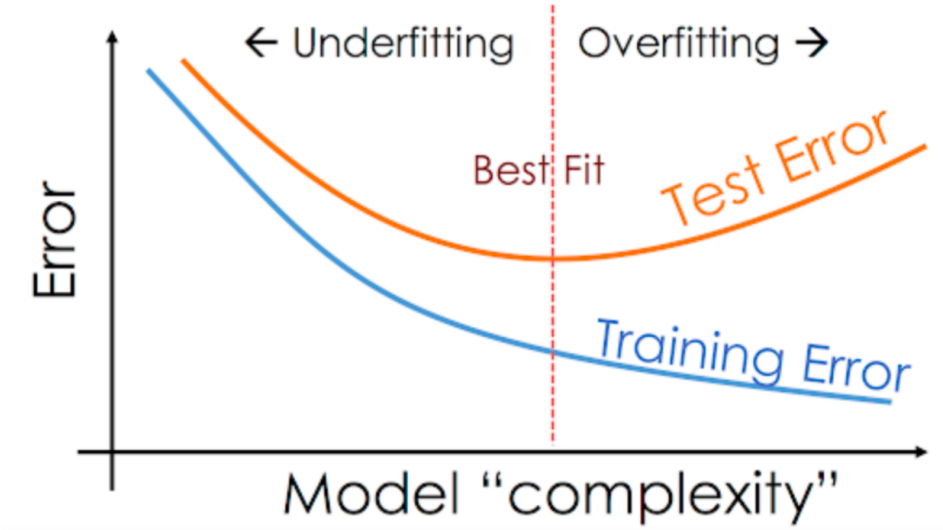
    2. Error on train and held out/validation sets



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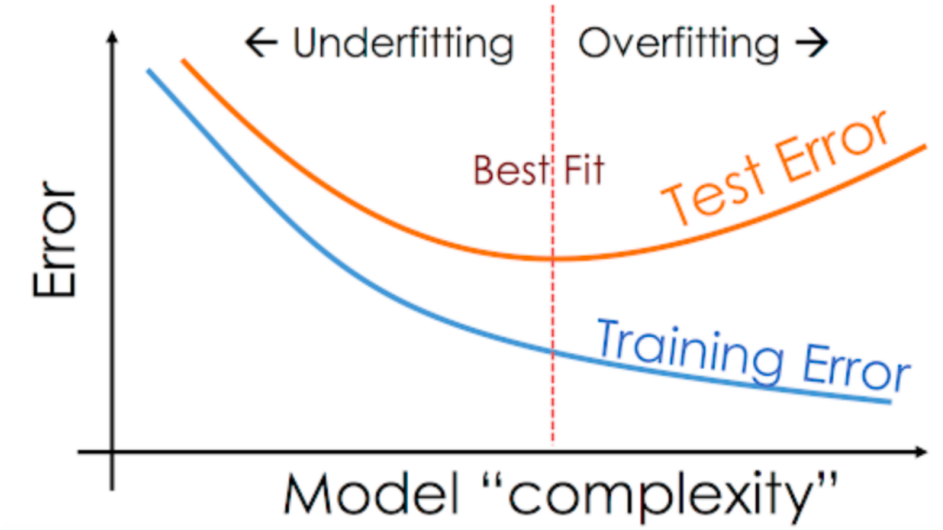

3. Cross validation is often used for estimating the generalization (hence limit overfitting)

Capacity

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2. More rigorous notion is VC dimension

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1. Although it is difficult to define precisely, in practice it is not very hard to manipulate it for a given class of models
2. In general overfitting can be controlled by
   - Restricting the space of functions $\mathcal{F}$ (regularization, constrained optimization)
   - Making the choice of optimal function f^* less dependent on the data (e.g. ensemble methods)