E9 205 Machine Learning for Signal Processing

Neural Networks - Generalization

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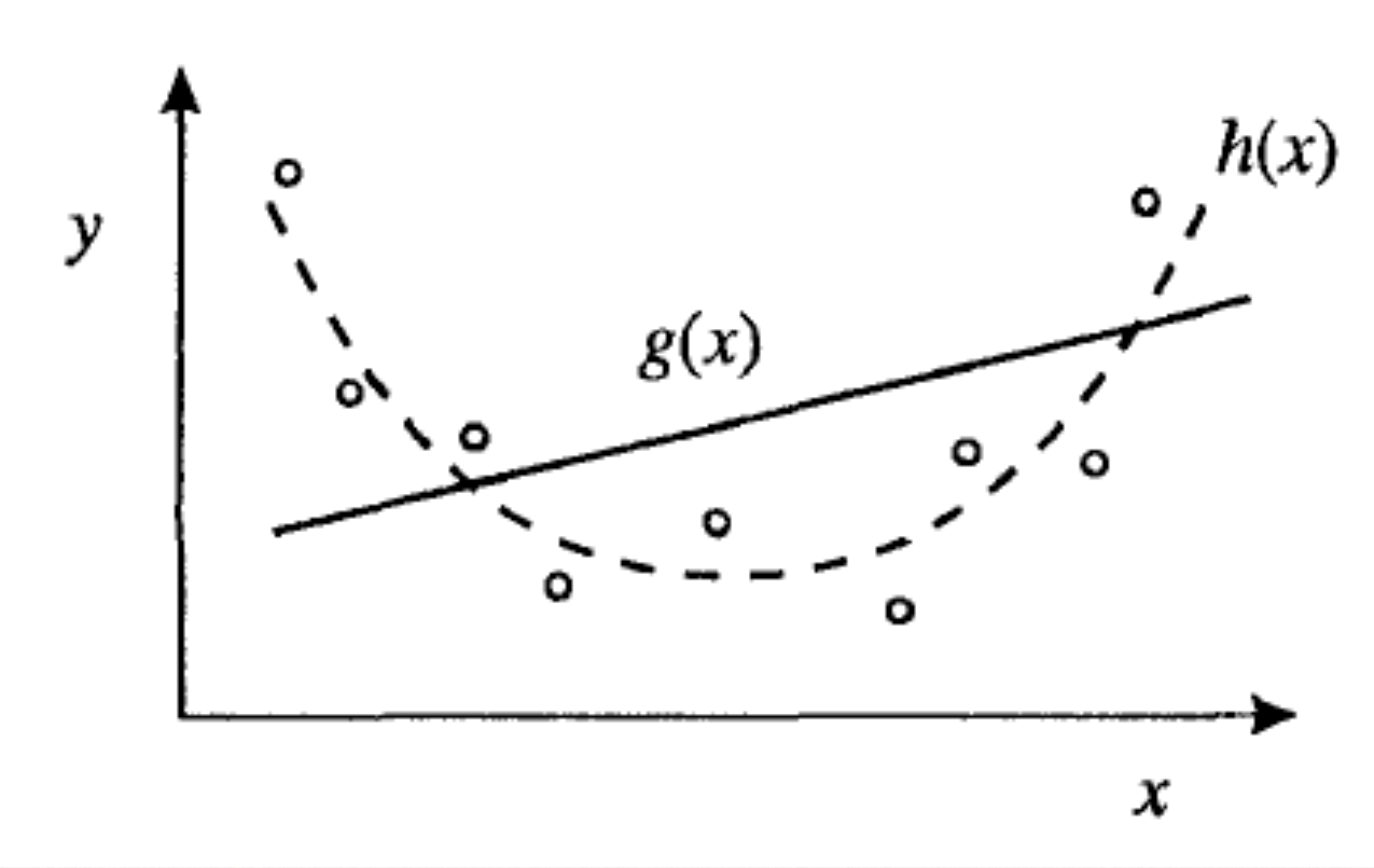
LEAP

Bias and Variance In Neural Network Training

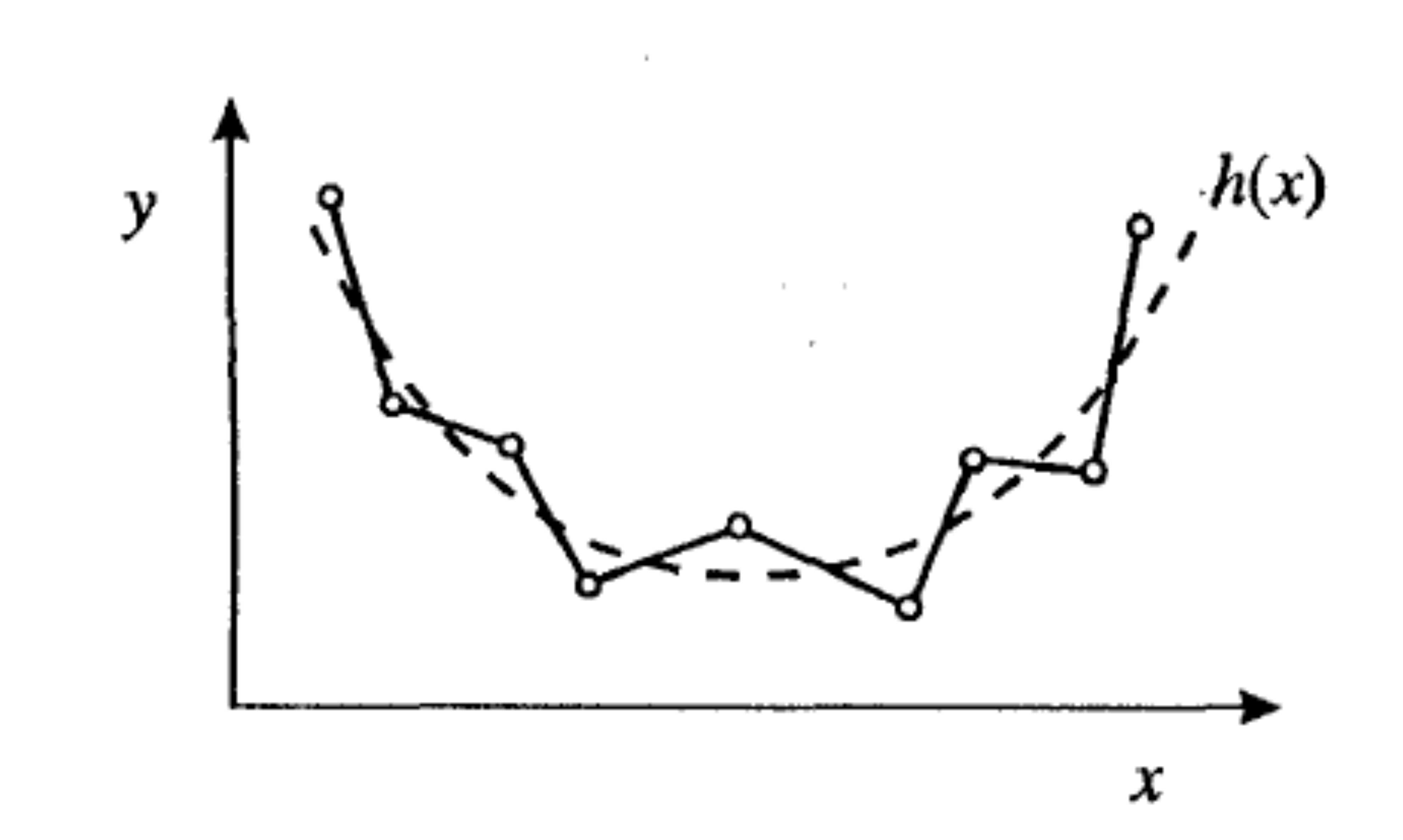
$$(\text{bias})^2 = \frac{1}{2}\int \{\mathcal{E}_D[y(\mathbf{x})] - \langle t|\mathbf{x}\rangle\}^2 p(\mathbf{x})\, d\mathbf{x}$$

$$\text{variance} = \frac{1}{2}\int \mathcal{E}_D[\{y(\mathbf{x}) - \mathcal{E}_D[y(\mathbf{x})]\}^2] p(\mathbf{x})\, d\mathbf{x}.$$

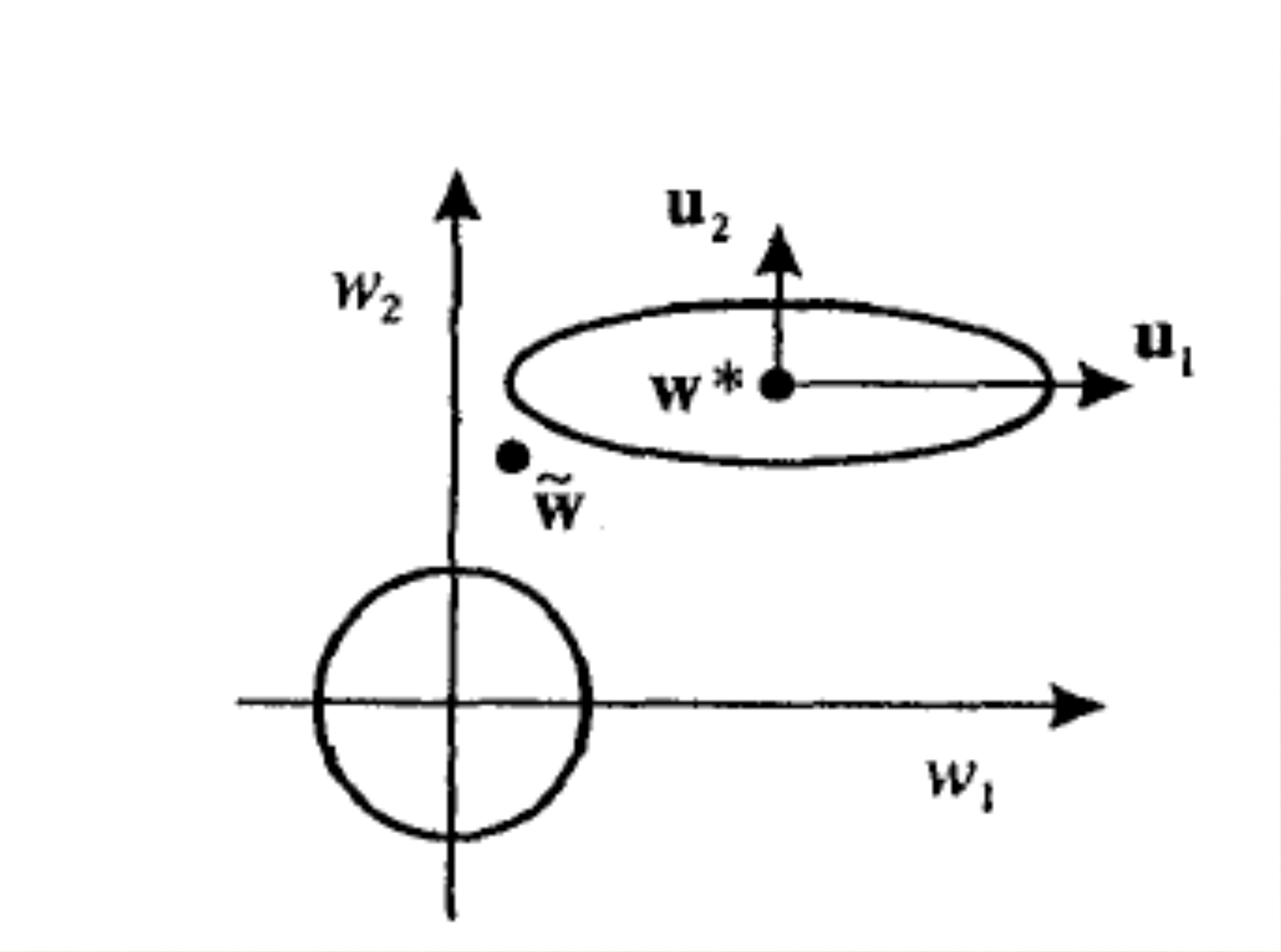
Underfit



Overfit

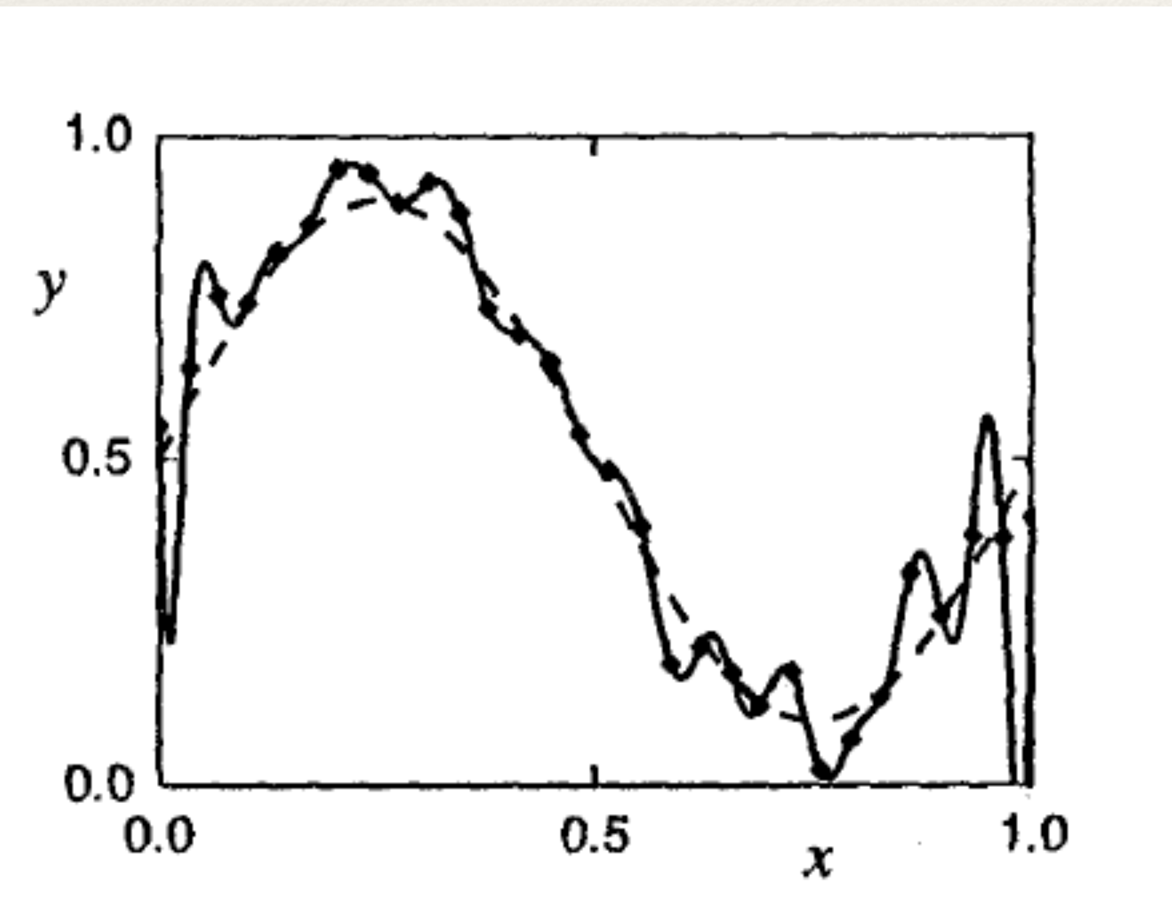


Weight Decay Based Regularization

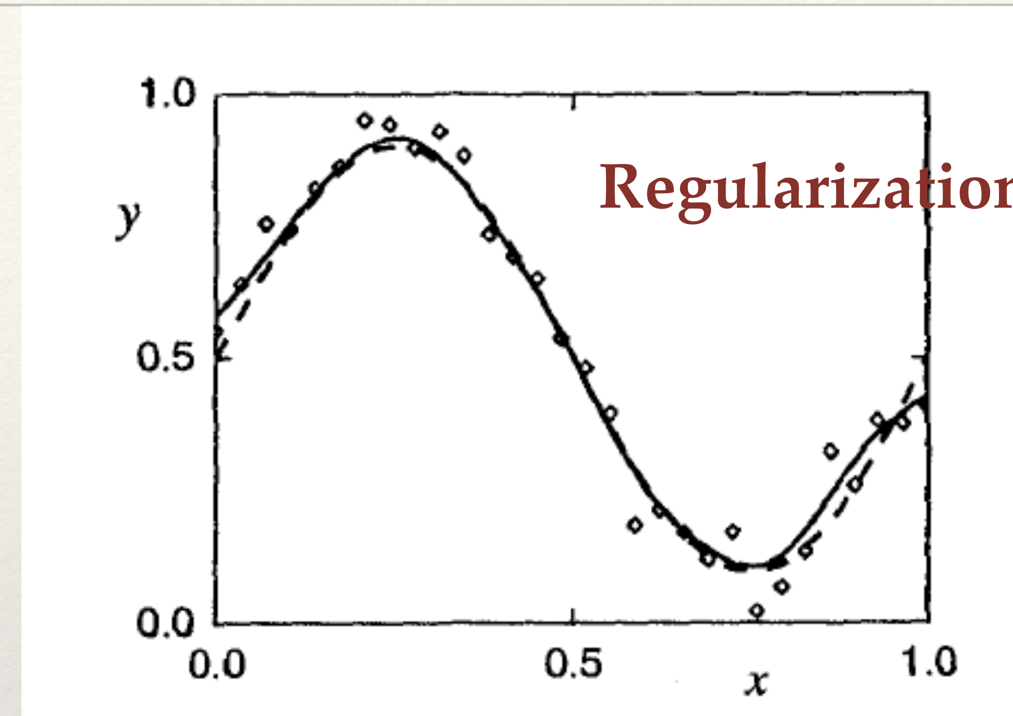


Weight Decay Regularization

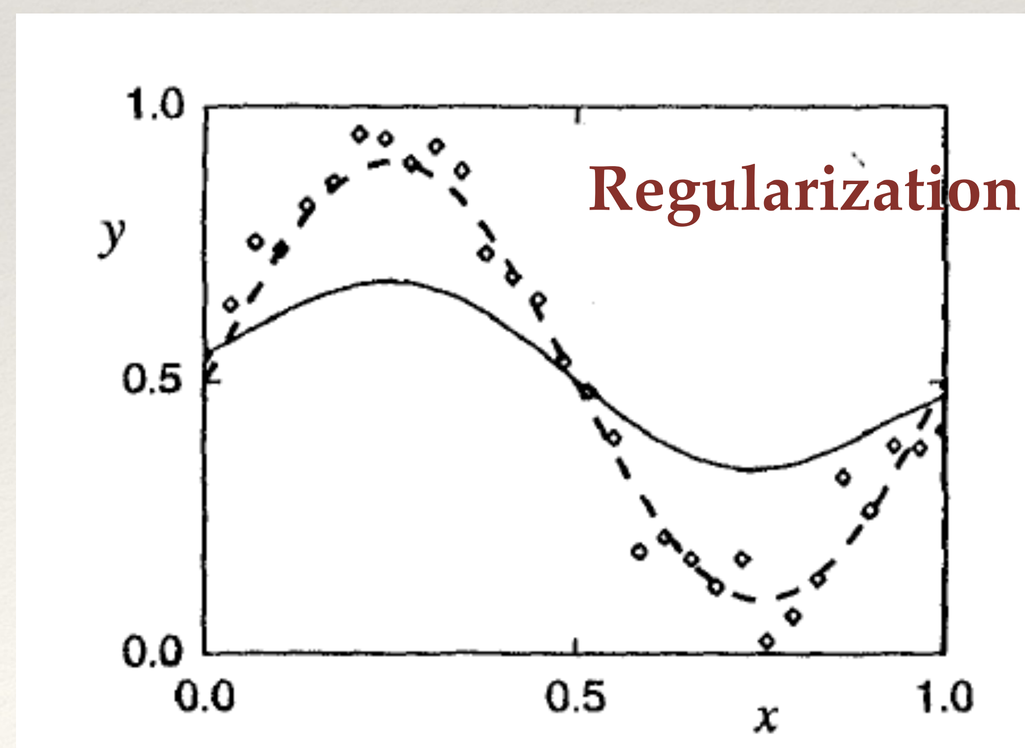
Regularization = 0



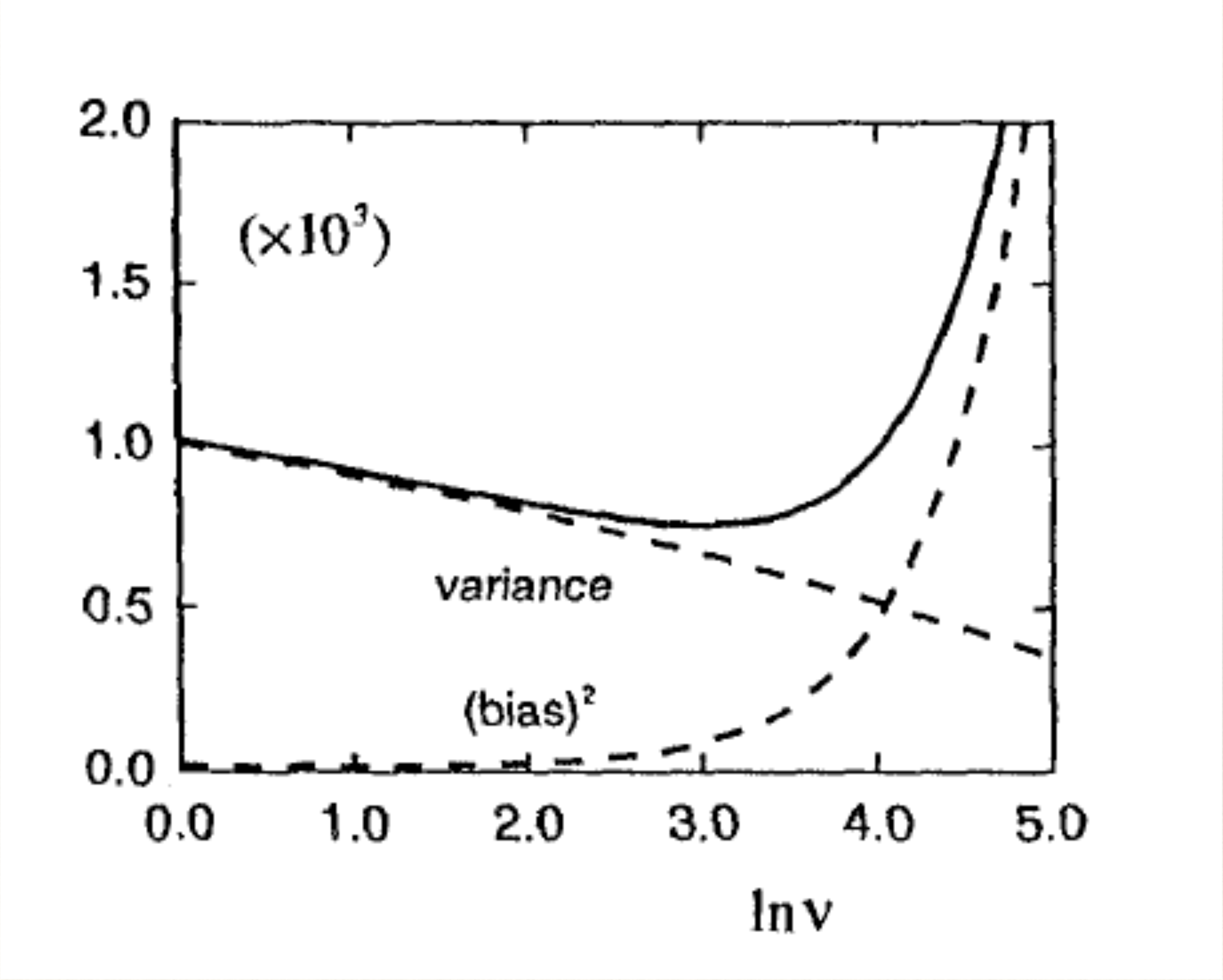
Regularization = 40



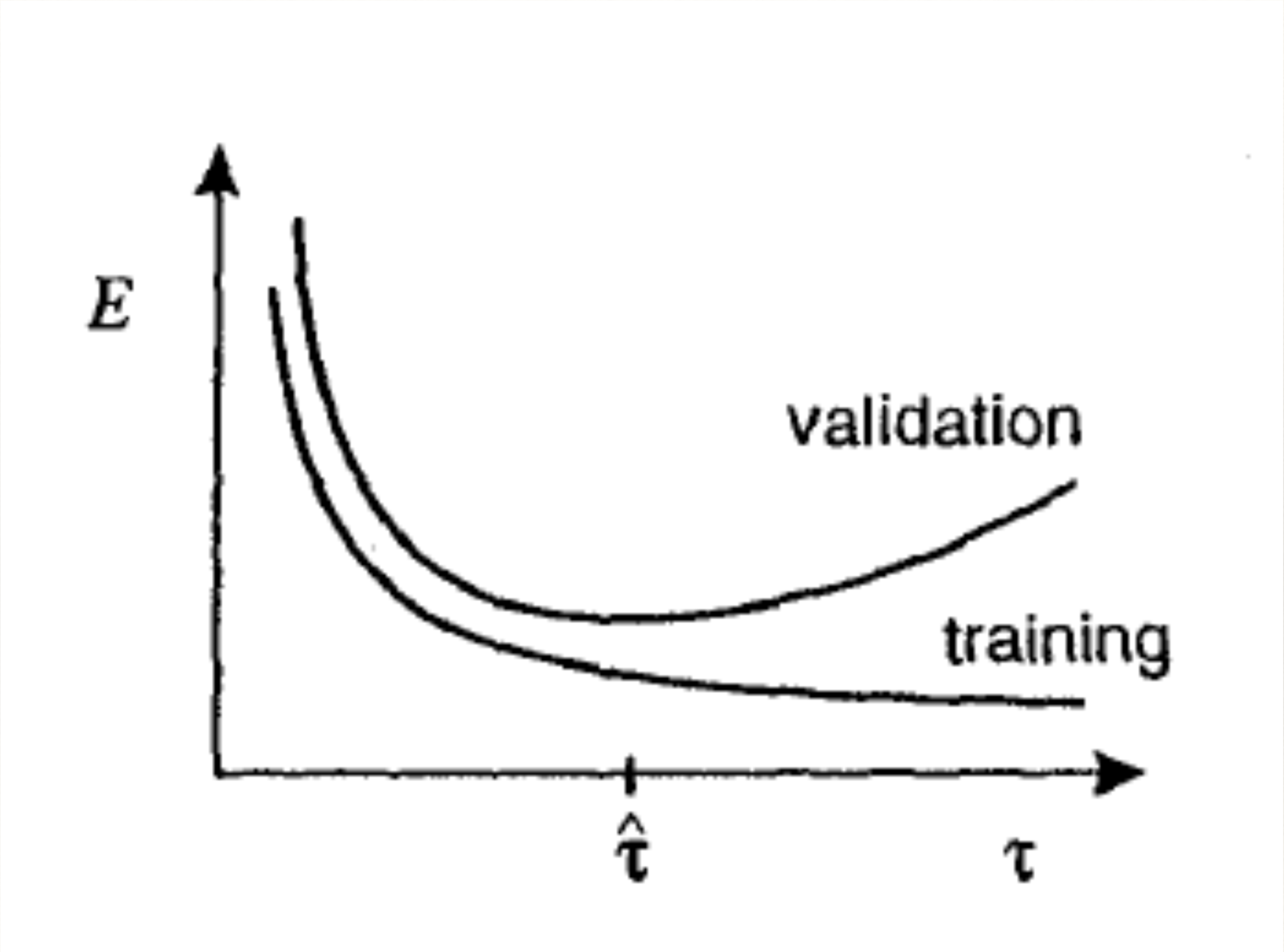
Regularization = 4000



Regularization Effect on Learning



Early Stopping

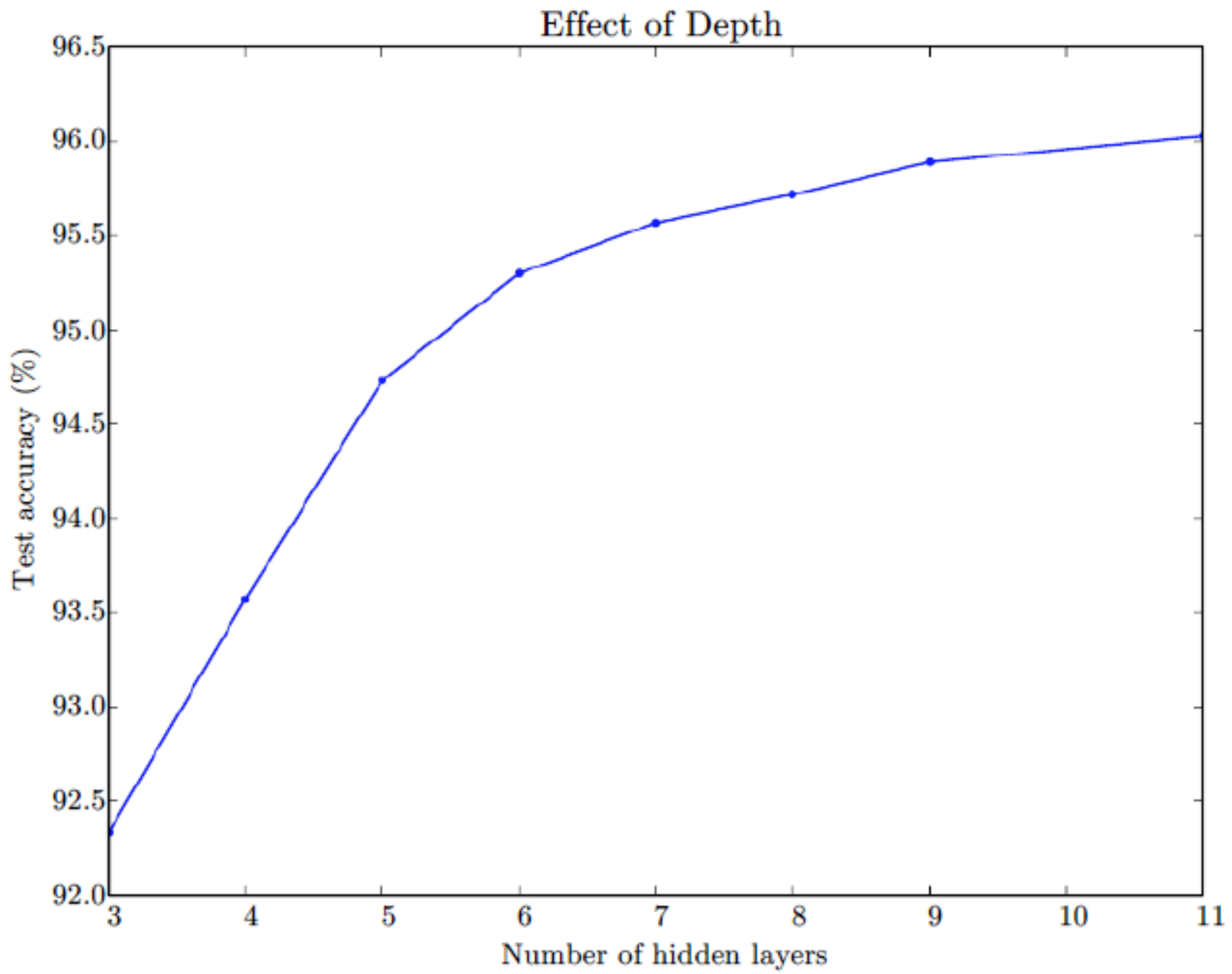


Most Popular in Practice

Neural Networks - Summary

- Details of Architecture
- Computation of gradient using back propagation.
- Error function and output layer activation
    - Neural networks estimate posterior probabilities
- Learning in Neural networks
    - Gradient descent - Properties
- Generalization of Neural Networks

Need for Depth



$$\boldsymbol{h}^{(1)} = g^{(1)}\left(\boldsymbol{W}^{(1)\top}\boldsymbol{x} + \boldsymbol{b}^{(1)}\right)$$

$$\boldsymbol{h}^{(2)} = g^{(2)}\left(\boldsymbol{W}^{(2)\top}\boldsymbol{h}^{(1)} + \boldsymbol{b}^{(2)}\right)$$

Need for Depth