Deep Learning

6.1 Going Deeper: Benefits of depth

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Depth and performance

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2. LeNet (8), AlexNet (8), VGG (16, 19), GoogLeNet (22, . . . , 76), ResNet (34, . . . , 152)

Depth and Performance

model	top-1 err.	top-5 err.
VGG-16 [41]	28.07	9.33
GoogLeNet [44]	-	9.15
PReLU-net [13]	24.27	7.38
plain-34	28.54	10.02
ResNet-34 A	25.03	7.76
ResNet-34 B	24.52	7.46
ResNet-34 C	24.19	7.40
ResNet-50	22.85	6.71
ResNet-101	21.75	6.05
ResNet-152	**21.43**	**5.71**

Figure credits: He et al. 2015

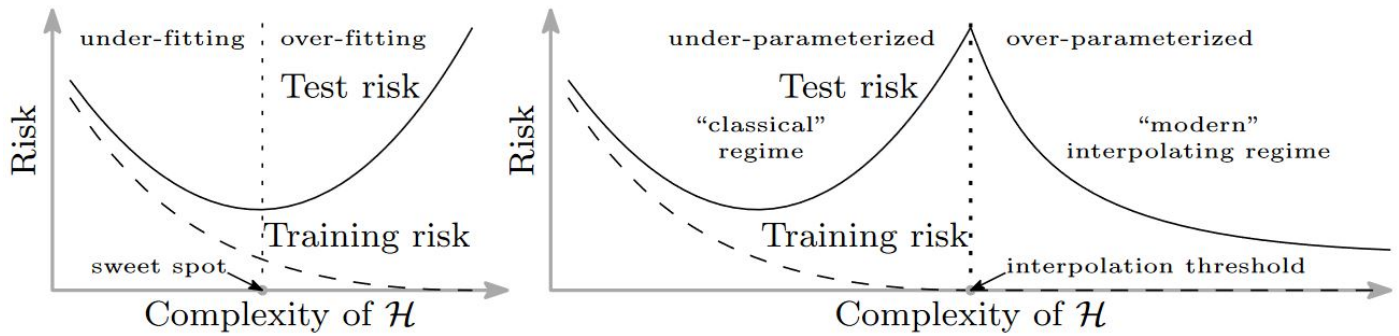
Complexity vs. depth and width

1. A measure of complexity of the mapping learned by the DNN increases
   - exponentially with its depth
   - linearly with the layers' width

Telgarsky 2015, 2016

Depth and Over-fitting

1. Contrary to what we have discussed in Bias-Variance decomposition, Over parameterizing a DNN often improves the performance



(a) U-shaped "bias-variance" risk curve

(b) "double descent" risk curve

Belkin et al. 2018

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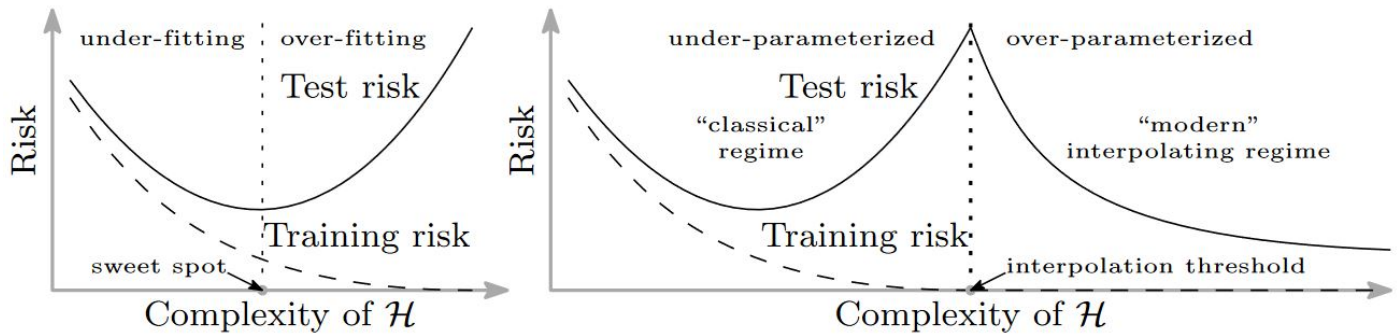
2. Only bias component (along with regularization) drives the optimization



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3. Gradients should not vanish
4. Gradients should be homogeneous at all the layers

Gradient and Depth

1. Because of our concern to take care of gradients, we often compromise on the family of functions learned by the DNN architectures