**HW to Chapter 9 "Fitting, Bias, Regularization, and Dropout"**

**Non-programming Assignment:**

1. What are underfitting and overfitting?

**Underfitting** occurs when a model is too simple to capture the underlying structure of the data, leading to poor performance on both training and validation sets. Overfitting happens when a model is too complex and captures noise in the training data, performing well on the training set but poorly on unseen data​.

1. What may cause early stopping of the gradient descent optimization process?

**Early stopping** may occur when the validation loss starts to increase while the training loss continues to decrease, indicating that the model is beginning to overfit. Monitoring validation performance and halting training when overfitting is detected helps to find the optimal model​.

1. Describe the bias-variance tradeoff and their relationship.

**Bias** refers to errors due to incorrect assumptions in the learning model (e.g., a too-simple model). **Variance** refers to sensitivity to fluctuations in the training data. Reducing bias increases variance and vice versa. Achieving a good balance between bias and variance is key to building models that generalize well​.

1. Describe regularization as a method and the reasons for it.

**Regularization** is a technique used to reduce overfitting by penalizing large weights in the model. Common regularization techniques include **L2 regularization** (which adds a penalty based on the square of the weights) and **L1 regularization** (which encourages sparsity in the model). These methods help to simplify the model and improve generalization​.

1. Describe dropout as a method and the reasons for it.

**Dropout** randomly sets a fraction of the neurons in the network to zero during training. This prevents neurons from becoming overly dependent on each other and encourages the network to learn more robust features. Dropout reduces overfitting by making the network more resilient to noise and variations in the input data​.