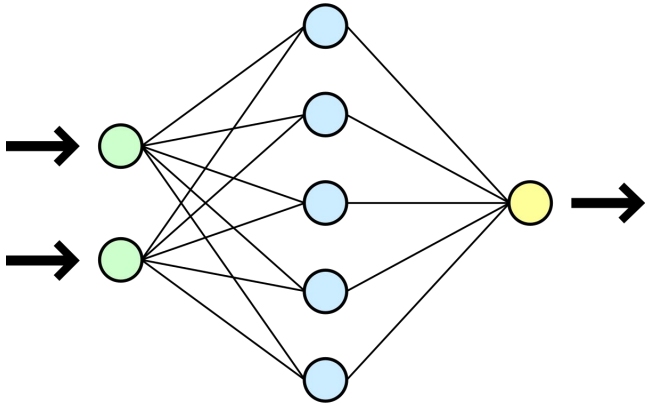

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Neural Networks

Overfitting and Underfitting

Recap - Last Video

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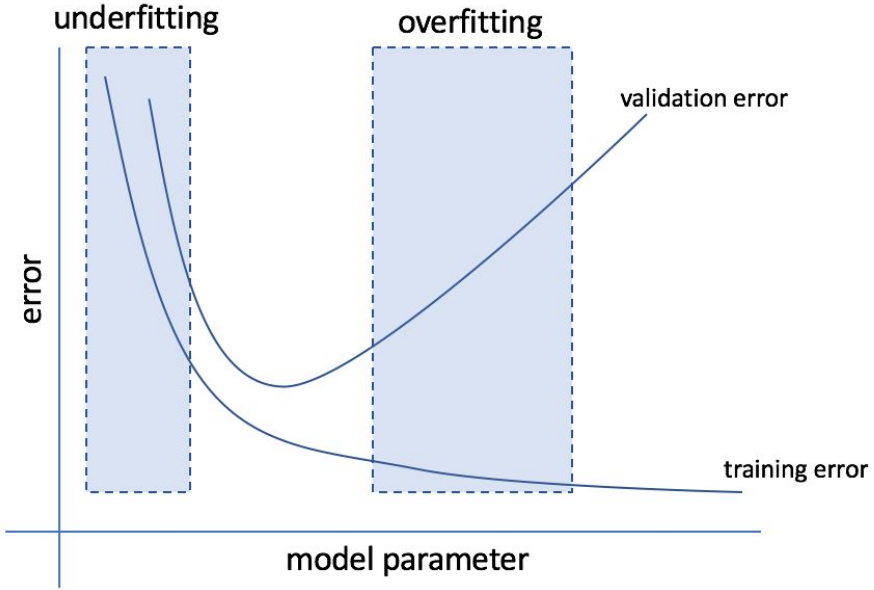
- Creating and Training a Neural Network on Vaccine Trial data
- Making Predictions with the Trained Neural Network

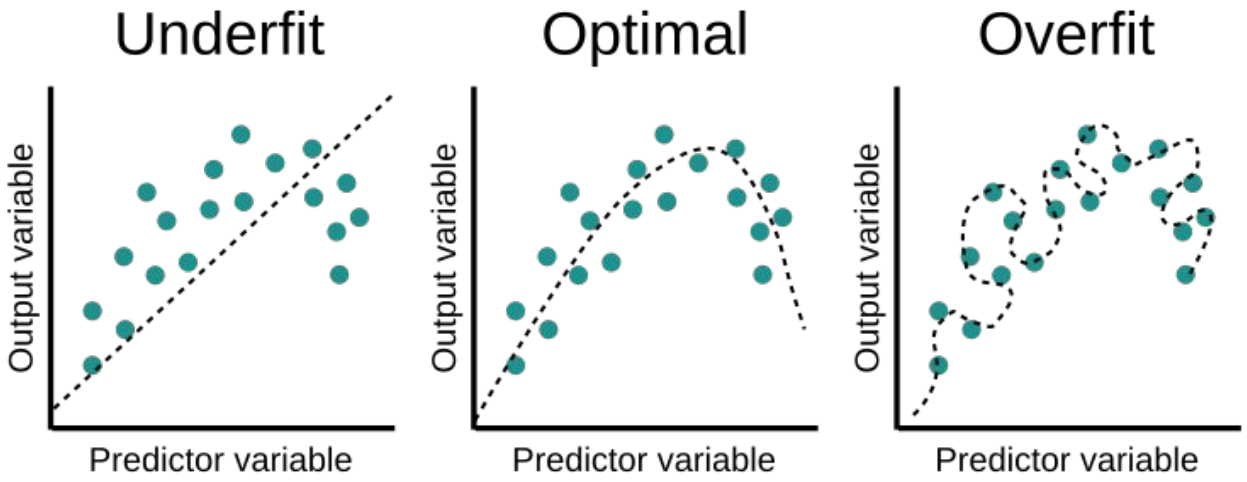
```
model = Sequential([
      Dense(units=12, input_shape=(1,), activation='relu'),
      Dense(units=24, activation='relu'),
      Dense(units=12, activation='relu'),
      Dense(units=2, activation='softmax')
])
```

```
Epoch 1/30
237/237 - 1s - loss: 0.7182 - accuracy: 0.4880 - val_loss: 0.6905 - val_accuracy: 0.5410
Epoch 2/30
237/237 - 0s - loss: 0.6615 - accuracy: 0.8305 - val_loss: 0.6345 - val_accuracy: 0.9067
Epoch 3/30
237/237 - 0s - loss: 0.6099 - accuracy: 0.9228 - val_loss: 0.5887 - val_accuracy: 0.9390
Epoch 4/30
237/237 - 0s - loss: 0.5571 - accuracy: 0.9462 - val_loss: 0.5345 - val_accuracy: 0.9467
```

Overfitting and Underfitting Overview

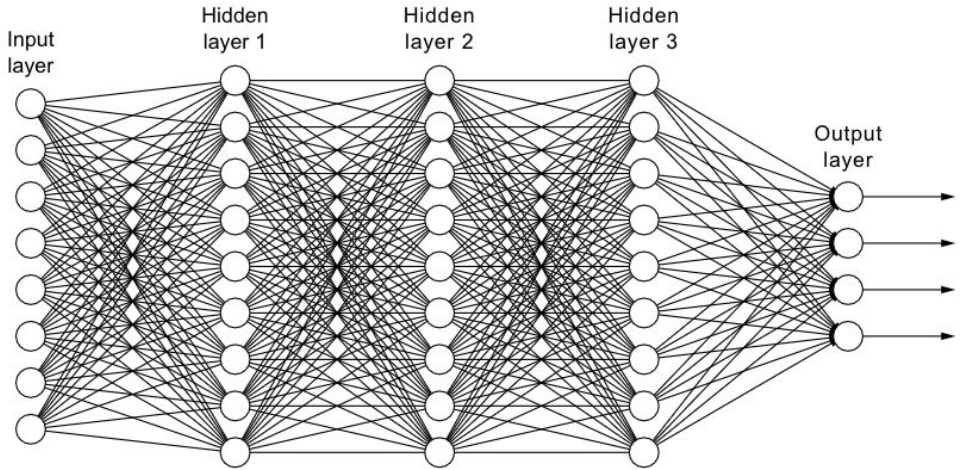


Overfitting and Underfitting the Data



How to reduce Overfitting?

- Reduce complexity of Neural Network
- Regularization
- Dropout
- Reduce the number of epochs - the training duration



Regularization in Keras

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- `kernel_regularizer`: Regularizer to apply a penalty on the layer's kernel
- `bias_regularizer`: Regularizer to apply a penalty on the layer's bias
- `activity_regularizer`: Regularizer to apply a penalty on the layer's output

```
from tensorflow.keras import layers
from tensorflow.keras import regularizers

layer = layers.Dense(
    units=64,
    kernel_regularizer=regularizers.l1_l2(l1=1e-5, l2=1e-4),
    bias_regularizer=regularizers.l2(1e-4),
    activity_regularizer=regularizers.l2(1e-5)
)
```

How to reduce Underfitting?

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- Make the Neural Network more complex
- Add more training data so the network can learn more about the specific task
- Preprocessing of the data - Remove noise as an example
- Increase number of epochs - Increase training duration
- Fine-tune parameters for the network and training process