

What is overfitting?

Overfitting is an undesirable machine learning behavior that occurs when the machine learning model gives accurate predictions for training data but not for new data. When data scientists use machine learning models for making predictions, they first train the model on a known data set. Then, based on this information, the model tries to predict outcomes for new data sets. An overfit model can give inaccurate predictions and cannot perform well for all types of new data.

Why overfitting occurs?

- The training data size is too small and does not contain enough data samples to accurately represent all possible input data values.
- The training data contains large amounts of irrelevant information, called noisy data.
- The model trains for too long on a single sample set of data.
- The model complexity is high, so it learns the noise within the training data.

How overfitting can be addressed or prevented?

- Early Stopping: Early stopping prevents overfitting by halting training before the model learns noise in the data. Timing is critical to ensure accurate results, and it involves monitoring a validation metric to stop training.
- Pruning: Pruning, or feature selection, retains important features and eliminates irrelevant ones, improving model efficiency. For instance, in image classification, prioritizing features like face shape while ignoring less impactful ones, like eye shape.
- Regularization: Regularization reduces overfitting by assigning penalties to less important features during training. In predicting housing prices, it may assign lower penalties to influential factors like population growth and higher penalties to less significant factors like average annual temperature.
- Ensembling: Ensembling combines predictions from multiple models, enhancing overall accuracy. Bagging trains models in parallel, while boosting trains them sequentially, correcting errors. Ensembling improves predictive performance and robustness by leveraging diverse models.
- Data Augmentation: Data augmentation enhances generalization by introducing variations in training data, such as translation and rotation. It prevents overfitting by making the model's training set appear unique, helping it learn robust characteristics from diverse examples.

What is underfitting?

Underfitting is another type of error that occurs when the model cannot determine a meaningful relationship between the input and output data. You get underfit models if they have not trained for the appropriate length of time on a large number of data points.

Difference between underfitting vs. overfitting?

Underfit models experience high bias—they give inaccurate results for both the training data and test set. On the other hand, overfit models experience high variance—they give accurate results for the training set but not for the test set. More model training results in less bias but variance can increase. Data scientists aim to find the sweet spot between underfitting and overfitting when fitting a model. A well-fitted model can quickly establish the dominant trend for seen and unseen data sets.

How does regularization contribute to preventing overfitting in machine learning models?

Regularization refers to techniques that are used to calibrate machine learning models in order to minimize the adjusted loss function and prevent overfitting or underfitting.