

Glossary

Definitions of common machine learning terms.

Accuracy

Percentage of correct predictions made by the model.

Algorithm

A method, function, or series of instructions used to generate a machine learning [model](#). Examples include linear regression, decision trees, support vector machines, and neural networks.

Attribute

A quality describing an observation (e.g. color, size, weight). In Excel terms, these are column headers.

Bias metric

What is the average difference between your predictions and the correct value for that observation?

- **Low bias** could mean every prediction is correct. It could also mean half of your predictions are above their actual values and half are below, in equal proportion, resulting in low average difference.
- **High bias** (with low variance) suggests your model may be underfitting and you're using the wrong architecture for the job.

Bias term

Allow models to represent patterns that do not pass through the origin. For example, if all my features were 0, would my output also be zero? Is it possible there is some base value upon which my features have an effect? Bias terms typically accompany weights and are attached to neurons or filters.

Categorical Variables

Variables with a discrete set of possible values. Can be ordinal (order matters) or

nominal (order doesn't matter).

Classification

Predicting a categorical output (e.g. yes or no?, blue, green or red?).

Classification Threshold

The lowest probability value at which we're comfortable asserting a positive classification. For example, if the predicted probability of being diabetic is $> 50\%$, return True, otherwise return False.

Clustering

Unsupervised grouping of data into buckets.

Confusion Matrix

Table that describes the performance of a classification model by grouping predictions into 4 categories.

- **True Positives:** we *correctly* predicted they do have diabetes
- **True Negatives:** we *correctly* predicted they don't have diabetes
- **False Positives:** we *incorrectly* predicted they do have diabetes (Type I error)
- **False Negatives:** we *incorrectly* predicted they don't have diabetes (Type II error)

Continuous Variables

Variables with a range of possible values defined by a number scale (e.g. sales, lifespan).

Deduction

A top-down approach to answering questions or solving problems. A logic technique that starts with a theory and tests that theory with observations to derive a conclusion. E.g. We suspect X, but we need to test our hypothesis before coming to any conclusions.

Deep Learning

Deep Learning is derived from one machine learning algorithm called perceptron or multi layer perceptron that gain more and more attention nowadays because of its success in different fields like, computer vision to signal processing and medical diagnosis to self-driving cars. As all other AI algorithms deep learning is from decades, but now today we have more and more data and cheap computing

power that make this algorithm really powerful to achieve state of the art accuracy. In modern world this algorithm known as artificial neural network. Deep learning is much more than traditional artificial neural network. But it was highly influenced by machine learning's neural network and perceptron network.

Dimension

Dimension for machine learning and data scientist is different from physics, here dimension of data means how much feature you have in your data ocean (data-set). e.g. in case of object detection application, flattened image size and color channel (e.g. $28 \times 28 \times 3$) is a feature of the input set. In case of house price prediction (maybe) house size is the data-set so we call it 1 dimensional data.

Epoch

An epoch describes the number of times the algorithm sees the entire data set.

Extrapolation

Making predictions outside the range of a dataset. E.g. My dog barks, so all dogs must bark. In machine learning we often run into trouble when we extrapolate outside the range of our training data.

Feature

With respect to a dataset, a feature represents an [attribute](#) and value combination. Color is an attribute. "Color is blue" is a feature. In Excel terms, features are similar to cells. The term feature has other definitions in different contexts.

Feature Selection

Feature selection is the process of selecting relevant features from a data-set for creating a Machine Learning model.

Feature Vector

A list of features describing an observation with multiple attributes. In Excel we call this a row.

Hyperparameters

Hyperparameters are higher-level properties of a model such as how fast it can learn (learning rate) or complexity of a model. The depth of trees in a Decision Tree or number of hidden layers in a Neural Networks are examples of hyper

parameters.

Induction

A bottoms-up approach to answering questions or solving problems. A logic technique that goes from observations to theory. E.g. We keep observing X, so we **<i>infer</i> that Y must be True.**

Instance

A data point, row, or sample in a dataset. Another term for [observation](#).

Learning Rate

The size of the update steps to take during optimization loops like [Gradient Descent](#). With a high learning rate we can cover more ground each step, but we risk overshooting the lowest point since the slope of the hill is constantly changing. With a very low learning rate, we can confidently move in the direction of the negative gradient since we are recalculating it so frequently. A low learning rate is more precise, but calculating the gradient is time-consuming, so it will take us a very long time to get to the bottom.

Loss

Loss = true_value(from data-set)- predicted value(from ML-model) The lower the loss, the better a model (unless the model has over-fitted to the training data). The loss is calculated on training and validation and its interpretation is how well the model is doing for these two sets. Unlike accuracy, loss is not a percentage. It is a summation of the errors made for each example in training or validation sets.

Machine Learning

Mitchell (1997) provides a succinct definition: “A computer program is said to learn from experience E with respect to some

class of tasks T and performance measure P, if its performance at tasks in T, as measured by P, improves with experience E. In simple language machine learning is a field in which human made algorithms have an ability learn by itself or predict future for unseen data.

Model

A data structure that stores a representation of a dataset (weights and biases). Models are created/learned when you train an algorithm on a dataset.

Neural Networks

Contribute a definition!

Normalization

Restriction of the values of weights in regression to avoid overfitting and improving computation speed.

Null Accuracy

Baseline accuracy that can be achieved by always predicting the most frequent class ("B has the highest frequency, so let's guess B every time").

Observation

A data point, row, or sample in a dataset. Another term for [instance](#).

Overfitting

Overfitting occurs when your model learns the training data too well and incorporates details and noise specific to your dataset. You can tell a model is overfitting when it performs great on your training/validation set, but poorly on your test set (or new real-world data).

Parameters

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Precision

In the context of binary classification (Yes/No), precision measures the model's performance at classifying positive observations (i.e. "Yes"). In other words, when a positive value is predicted, how often is the prediction correct? We could game this metric by only returning positive for the single observation we are most confident in.

$$P = \frac{TruePositives}{TruePositives + FalsePositives}$$

$$P = \frac{TruePositives}{TruePositives + FalsePositives}$$

Recall

Also called sensitivity. In the context of binary classification (Yes/No), recall measures how “sensitive” the classifier is at detecting positive instances. In other words, for all the true observations in our sample, how many did we “catch.” We could game this metric by always classifying observations as positive.

$$R = \frac{TruePositives}{TruePositives + FalseNegatives}$$

$$R = \frac{TruePositives}{TruePositives + FalseNegatives}$$

Recall vs Precision

Say we are analyzing Brain scans and trying to predict whether a person has a tumor (True) or not (False). We feed it into our model and our model starts guessing.

- **Precision** is the % of True guesses that were actually correct! If we guess 1 image is True out of 100 images and that image is actually True, then our precision is 100%! Our results aren't helpful however because we missed 10 brain tumors! We were super precise when we tried, but we didn't try hard enough.
- **Recall**, or Sensitivity, provides another lens which with to view how good our model is. Again let's say there are 100 images, 10 with brain tumors, and we correctly guessed 1 had a brain tumor. Precision is 100%, but recall is 10%. Perfect recall requires that we catch all 10 tumors!

Regression

Predicting a continuous output (e.g. price, sales).

Regularization

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Reinforcement Learning

Training a model to maximize a reward via iterative trial and error.

Segmentation

Contribute a definition!

Specificity

In the context of binary classification (Yes/No), specificity measures the model's performance at classifying negative observations (i.e. "No"). In other words, when the correct label is negative, how often is the prediction correct? We could game this metric if we predict everything as negative.

$$S = \frac{TrueNegatives}{TrueNegatives + FalsePositives}$$

$$S = \frac{TrueNegatives}{TrueNegatives + FalsePositives}$$

Supervised Learning

Training a model using a labeled dataset.

Test Set

A set of observations used at the end of model training and validation to assess the predictive power of your model. How generalizable is your model to unseen data?

Training Set

A set of observations used to generate machine learning models.

Transfer Learning

Contribute a definition!

Type 1 Error

False Positives. Consider a company optimizing hiring practices to reduce false positives in job offers. A type 1 error occurs when candidate seems good and they hire him, but he is actually bad.

Type 2 Error

False Negatives. The candidate was great but the company passed on him.

Underfitting

Underfitting occurs when your model over-generalizes and fails to incorporate relevant variations in your data that would give your model more predictive power. You can tell a model is underfitting when it performs poorly on both training and test sets.

Universal Approximation Theorem

A neural network with one hidden layer can approximate any continuous function but only for inputs in a specific range. If you train a network on inputs between -2 and 2, then it will work well for inputs in the same range, but you can't expect it to generalize to other inputs without retraining the model or adding more hidden neurons.

Unsupervised Learning

Training a model to find patterns in an unlabeled dataset (e.g. clustering).

Validation Set

A set of observations used during model training to provide feedback on how well the current parameters generalize beyond the training set. If training error decreases but validation error increases, your model is likely overfitting and you should pause training.

Variance

How tightly packed are your predictions for a particular observation relative to each other?

- **Low variance** suggests your model is internally consistent, with predictions varying little from each other after every iteration.
- **High variance** (with low bias) suggests your model may be overfitting and reading too deeply into the noise found in every training set.

References

- [1] <http://robotics.stanford.edu/~ronnyk/glossary.html>