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How is Linear Algebra used in Machine Learning?

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Vignesh Natarajan, Strang is a rockstar.
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Algebra is the branch of mathematics that deals with unknown values being represented in the form of variables. Linear algebra is an extension of the same.

Linear algebra is an area that primarily deals with representation of data conforming to certain notations and practices. Broadly speaking, in linear algebra data is represented in the form of **linear equations**. These linear equations are in turn represented in the form of **matrices and vectors**. Vectors can be looked at as a single dimensional matrix. So linear algebra mainly deals with representation of data in the form of matrices.

Why is this useful in Machine Learning?

Machine learning is data intensive. The math side of Machine Learning is extremely heavy on the side of calculations. This is because, Machine Learning algorithms aren't very effective unless they're trained and are operating on large data sets, **ranging from hundreds of training examples to millions of testing data.**

It has been observed through practice that representing large sets of data in the form of matrices help us visualize the data better. One very important advantage of matrices is that, all the processes/operations performed on matrcies are batch processes. It means that, though we have thousands and millions of data examples we don't process each example individually. Usually, any algorithm or a design technique is applied to the entire data set at the same time or subsequently without focusing on the individual data examples.

Matrices help us to look at all the data as a single entity and also let us process them as and how we look at them. This is why linear algebra is a very close and extremely important sidekick of Machine Learning.

Written 17 Jul, 2013.

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Linear Algebra can be used to process data to accomplish such tasks as graphical transformations, face morphing, object detection and tracking, audio and image compression, edge detection, blurring, signal processing and hell lot of other tasks.

Linear algebra works as a computation engine in ML. Most ML algorithms use a classifier or regressor and train it by minimising error between the value calculated by the nascent classifier and the actual value from the training data. This can be done either iteratively or using linear algebra techniques. If the latter, then the technique is usually ***SVD*** or some variant.

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In the recommendation systems, data handling system a lot of data is handled and All of the techniques in current use involve some type of matrix decomposition, a fundamental class of linear algebra techniques (e.g., non-negative matrix approximation, and positive-maximum-margin-matrix approximation)

It is very difficult to deal with large data so many techniques have been proposed to compress the data which are based on linear algebra. Principal Component Analysis is one of many techniques.

Written 15 Aug, 2014.

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EDIT: I'm adding the explanation I give my students, since I've included it in several of my comments on other answers:

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