AI/ML

Mathematics for Machine Learning - Why to Learn & What are the Best Free Resources?

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Why people hate Maths? If anyone wants to share their views on this question, please share it wherever you find this post. If you hate maths or not, this reasonable and resourceful guide is for you. In this post, We've curated the brain-friendly and best free resources to learn maths for machine learning. We've tried to cover the top resources that can help you learn core math concepts required for machine learning, including linear algebra, calculus, probability, statistics, optimization and more.

1. Linear Algebra & Trigonometry for Machine Learning

☞ Why you should learn linear algebra for machine learning?

In machine learning, most of the time we deal with scalars and vectors, and matrices. For example in logistic regression, we do vector-matrix multiplication. Sometimes we do clustering of input by using spectral clustering techniques, and for this, we need to know eigenvalues and eigenvectors. Linear algebra is also used in data preprocessing, data transformation, dimensionality reduction, and model evaluation.

☞ What are some of the core topics you should learn in linear algebra?

Topics such as Principal Component Analysis (PCA), Singular Value Decomposition (SVD), Eigen decomposition of a matrix, LU Decomposition, QR Decomposition/Factorization, Symmetric Matrices, Orthogonalization & Orthonormalization, Matrix Operations, Projections, Eigenvalues & Eigenvectors, Vector Spaces and Norms are needed for understanding the optimization methods used for machine learning

☞ What are some of best free resources to learn Linear Algebra?

Websites:

Website: **Learn Algebra with Math is Fun**

Website: **Learn Linear Algebra with the Learning Machine**

Website: **Introduction to Linear Algebra for Applied Machine Learning with Python**

YouTube Playlist and Lectures:

Youtube Playlist: **Essence of Linear Algebra by 3Blue1Brown**

Youtube Playlist: **Trigonometry by Khan Academy**

Youtube Playlist: **Linear Algebra by Dr Trefor Bazett**

Youtube Lecture: **Trigonometry Fundamentals by 3Blue1Brown**

Youtube Playlist: **Linear Algebra for Machine Learning By Applied AI Course**

Courses:

Course: **Linear Algebra by Khan Academy**

Course: **Gilbert Strang lectures on Linear Algebra (MIT)**

Course: **Coding The Matrix: Linear Algebra Through Computer Science Applications**

eBooks:

eBook: **Linear Algebra Abridged by Sheldon Axler**

eBook: **Introduction to Applied Linear Algebra – Vectors, Matrices, and Least Squares by Stephen Boyd and Lieven Vandenberghe**

eBook: **Linear Algebra by Georgiy Shilov**

eBook: **Deep Learning Book By Ian Goodfellow and Yoshua Bengio and Aaron**

Github & Cheats:

Github: **Linear Algebra and Calculus Cheat Sheets by Stanford University**

Cheat Sheets: **Trigonometry Cheats by Paul Dawkins**

Cheat Sheets: **Algebra Cheats by Paul Dawkins**

2. Probability and Statistics for Machine Learning

☞ What's the use of probability and statistics in machine learning?

Probability helps you to manage the uncertainty. Uncertainty means working with imperfect or incomplete information. And in Machine Learning, we build predictive models from uncertain data. But we can manage uncertainty using the tools of probability. Whereas Statistics help you to count well, normalize well, obtain distributions, find out the mean of your input feature, and its standard deviation. That's why knowledge of Probability and Statistics is important for machine learning.

☞ What are some of the core topics you should learn in stats and probability?

Some of the fundamental Statistical and Probability Theory needed for ML are Combinatorics, Probability Rules & Axioms, Bayes' Theorem, Random Variables, Variance and Expectation, Conditional and Joint Distributions, Standard Distributions (Bernoulli, Binomial, Multinomial, Uniform and Gaussian), Moment Generating Functions and more.

☞ What are some of the best free resources to learn Probability and Statistics?

Websites:

Website: **Seeing Theory - A Visual Introduction to Probability and Statistics**

Website: **Learn Probability and Statistics with Math is Fun**

YouTube Playlist and Lectures:

Youtube Playlist: **Statistics 110 - Probability by Harvard University**

Youtube Playlist: **Introduction to Probability by MIT**

Courses:

Course: **Introduction to Statistics by Udacity**

Course: **Probabilistic Systems Analysis and Applied Probability by MIT**

Course: **Statistics and Probability by Khan Academy**

eBooks:

eBook: **Introduction to Probability by Charles Miller Grinstead and J. Laurie Snell**

eBook: **An Introduction to Statistical Learning by Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani**

eBook: **Probability Theory: The Logic of Science by E. T. Jaynes**

eBook: **The Elements of Statistical Learning by Trevor Hastie, Robert Tibshirani and Jerome Friedman**

Github: **A Concrete Introduction to Probability Using Python By Peter Norvig**

Github: **Probability and Statistics Cheat Sheets by Stanford university**

Cheat Sheets: **Statistics Cheats by MIT**

3. Calculus for Machine Learning

☞ What's the use of calculus in machine learning?

Calculus helps us to explain the relationships between input and output variables. And Multivariate Calculus comes into the picture when you deal with a lot of features and huge data. That's why familiarity with multivariate calculus is essential for building a machine learning model.

☞ What are some of the core topics you should learn in calculus?

Some of the necessary topics include Differential and Integral Calculus, Partial Derivatives, Vector-Values Functions, Directional Gradient, Hessian, Jacobian, Laplacian and Lagragian Distribution.

☞ What are some of the best free resources to learn Calculus?

Websites:

Website: **Learn Calculus with The Learning Machine**

Website: **Learn Calculus with Math is Fun**

YouTube Playlist and Lectures:

Youtube Playlist: **Essence of Calculus by 3Blue1Brown**

Youtube Playlist: **Calculus 1**, **Calculus 2**, **Calculus 3** and **Calculus 4** by Dr Trefor Bazett

Youtube Playlist: **Single Variable Calculus by Penn Professor Robert Ghrist**

Youtube Playlist: **Mathematics for Machine Learning - Multivariate Calculus by Imperial College London**

Courses:

Course: **Single Variable Calculus by MIT**

Course: **Multivariable Calculus by MIT**

eBooks & Cheats:

eBook: **Calculus by Gilbert Strang**

eBook: **Introduction to Calculus Volume I** and **Volume II by J.H. Heinbockel**

Cheat Sheets: **Calculus Cheats by Paul Dawkins**

4. Optimizations Methods & Other Topics for Machine Learning

☞ What's the use of optimization in machine learning?

Optimization methods are important to understand the computational efficiency and scalability of our Machine Learning Algorithm. In the end, mostly all Machine learning algorithms come down to some optimization tasks

☞ What are some core topics you should learn in optimization methods?

Knowledge of data structures (Binary Trees, Hashing, Heap, Stack etc), Dynamic Programming, Randomized & Sublinear Algorithm, Graphs, Gradient/Stochastic Descents and Primal-Dual methods are needed.

Other important disciplines can include continuous functions limits, information theory, real and complex analysis (Sets and Sequences, Topology, Metric Spaces, Single-Valued and Continuous Functions, Limits, Cauchy Kernel, Fourier Transforms) and Manifolds.

☞ What are some of the best free resources to learn Optimization and other remaining topics?

Website:

Website: **Learn Optimization with the Learning Machine**

YouTube Playlist and Lectures:

Youtube Playlist: **How Optimization for Machine Learning Works**

Youtube Lecture: **Optimization for Machine learning by DeepMind**

Course, eBook & Research Paper:

Course: **Optimization for Machine Learning**

eBook: **Convex Optimization by Lieven Vandenberghe and Stephen P. Boyd**

Research Paper: **A Survey of Optimization Methods from a Machine Learning**

☞ All in One Maths Resources (Algebra, Trigonometry, Calculus, Probability, Statistics, Optimization and more, everything at one place)

eBook: **Mathematics for Machine Learning by A. Aldo Faisal, Cheng Soon Ong, and Marc Peter Deisenroth**

Course: **Mathematics of Machine Learning by MIT**

Youtube Playlist: **Linear Algebra, Calculus and Probability for Machine Learning by Weights and Biases**

Youtube Playlist: **Mathematics of Machine Learning by Paul G Allen**

eBook: **Algebra, Topology, Differential Calculus, and Optimization Theory for Computer Science and Machine Learning**

Despite the immense possibilities of Machine Learning and Deep Learning, a thorough mathematical understanding of many of these techniques is necessary for a good grasp of the inner workings of the algorithms and getting good results. For that reason, we have curated and shared some of the best resources to learn mathematics for machine learning . We hope these resources will be helpful to you in learning and implementing maths behind machine learning. So, that's it for now. If you have any doubt or questions or suggestion, feel free to share your it with us wherever you're following us.

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