CSE 475: Statistical Methods in AI **Monsoon 2018**

Lec 2: Mathematics for ML

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The following is a list of topics in Linear Algebra, Probability and Statistics and Vector Calculus that you should revise to ensure that you can follow the topics in this course well.

Linear Algebra

You may find the "Essence of Linear Algebra" video series of the youtube channel: 3Blue1Brown quite useful for these.

1. *Vectors and Vector Spaces*:
   - Vectors, Dimensions
   - Length: L2-Norm; Unit vector
   - L1-Norm; Lp-Norm; L0-Norm; Linf-Norm
2. *Span and Basis*
   - Span of two/three vectors; Basis
   - Linear dependence and independence
   - Degenerate Cases
   - Orthonormal Basis
3. *Vector Operations*
   - Vector addition
   - Scalar multiplication
   - Dot product and Cross Product
   - Outer Product
4. *Linear Entities*
   - Line Representation
   - Distance from/along a line
   - Planes and Hyperplanes
5. *Matrices*
   - Matrix multiplication as Linear Transformation
   - Special Transformations: Rotation
   - Transformation as Basis change
   - Rank of a Matrix
   - Inverse of a Matrix
   - Pseudo-inverse
6. *Matrix Decomposition*
   - Eigen Values and Eigen Vectors

Probability and Statistics

1. *Random Variables and Probabilities*
   - Random Variables
   - Random Vectors
2. *Probability Distribution and Density Functions*
   - Binomial distribution
   - Poisson distribution
   - Gaussian density
   - Uniform density
   - Exponential density
3. *Multivariate Densities; Gaussian*
4. *Bayes Theorem of Decision Making*
5. *Covariance Matrices and Properties*

Vector Calculus

1. *Functions of Vectors*
   - $f : \mathbb{R} \rightarrow \mathbb{R}$
   - $f : \mathbb{R}^n \rightarrow \mathbb{R}$
   - $f : \mathbb{R}^n \rightarrow \mathbb{R}^m$
2. *Derivatives*
   - Derivative and Slope
   - Gradient: A vector of first partial derivatives
   - Hessian: A matrix of second partial derivatives
   - Jacobian: A matrix of first derivative of vector valued function.