BOSSCODER ACADEMY

MATHS FOR DATA SCIENCE

CHEAT SHEET

$$f(\omega) = \int_{-\infty}^{\infty} f(x) \cdot e^{-2\pi i x \omega}$$

$$\frac{\cos\alpha}{\sin\alpha} = \cot\alpha$$

1 LINEAR ALGEBRA

Concepts & Formulas:

- Vectors (v): Used to represent data points, features. $v=[v_1, v_2, ..., v_n]$
- Matrices (A): Two-dimensional arrays of numbers, used for data representation, transformations. $A\ [a_{ij}]$ where i is the row index, and j is the column index.
- Matrix Multiplication: $C = AB$ where $c_{ij} = \Sigma_k\ a_{ik}\ b_{kj}$
- Determinant: A scalar value that can be computed from the elements of a square matrix.
- Eigenvalues & Eigenvectors: Solve Av = λv. Eigenvalues (λ) are scalars, eigenvectors (v) are vectors.

Usage:

Fundamental in machine learning algorithms, especially in dimensionality reduction (PCA), systems of linear equations.

Glossary:

Matrix (A): Rectangular array of numbers.

Vector (v): Special case of matrix with only one column.

2 PROBABILITY

Concepts & Formulas:

Probability of Event (P(A)): $P(A) = \frac{\text{Number of favorable outcomes}}{\text{Total number of outcomes}}$

Conditional Probability: $P(A|B) = \frac{P(A \cap B)}{P(B)}$

Bayes' Theorem: $P(A|B) = \frac{P(B|A)P(A)}{P(B)}$

Probability Distributions: Normal, Binomial, Poisson distributions.

Usage:

Understanding data distributions, modeling uncertainty, basis for statistical inference and predictive models.

Glossary:

Event (A): Outcome or set of outcomes in an experiment

3 CALCULUS

Concepts & Formulas:

Derivative (f'(x)): Represents the rate of change of a function. $f'(x) = \lim_{h \to 0} \frac{f(x+h)-f(x)}{h}$

Integral (F(x)): Represents the area under the curve of a function. $F(x) = \int f(x)dx$

Gradient (∇t): Vector derivative in multivariate cases.

Usage:

Optimization problems, understanding change in algorithms, backpropagation in neural networks.

Glossary:

Function (f(x)): Relationship where each input is related to exactly one output.

Derivative (f'(x)): Instantaneous rate of change.

4 STATISTICS

Concepts & Formulas:

Mean(μ):$\mu = \frac{1}{N} \sum_{i=1}^{N} x_i$

Variance (σ^2): $\sigma^2 = \frac{1}{N} \sum_{i=1}^{N} (x_i - \mu)^2$

Standard Deviation (σ): $\sigma = \sqrt{\sigma^2}$

Correlation Coefficient (p): $p = \frac{cov(X,Y)}{\sigma_X \ \sigma_Y}$

Usage:

Descriptive analysis, hypothesis testing, regression analysis, data exploration.

Glossary:

Mean (μ): Average of all data points.

Variance (σ^2): Measure of data spread.

5 ALGORITHMIC COMPLEXITY

Concepts & Formulas:

Big O Notation:

Describes the upper bound of the time complexity of an algorithm. E.g., O(n), $O(n^2)$.

Usage:

Evaluating and comparing the efficiency of algorithms, especially in handling large datasets.

Glossary:

Big O (O(n)): Upper bound of the time complexity.

6 HYPOTHESIS TESTING

Concepts & Formulas:

Null Hypothesis (H0):

The hypothesis that there is no significant difference or effect.

P-value:

Probability of observing data at least as extreme as the data observed, under H0.

Z-test, t-test, Chi-square test:

Depending on data type and sample size.

Usage:

Making inferences about populations based on sample data, A/B testing.

Glossary:

Null Hypothesis (H0): Default assumption that there is no effect or difference.

7 FUNCTIONS

Concepts & Formulas:

Function:

A relation where each input has a single output. E.g. $f(x) = x^2$

Polynomial, Exponential, Logarithmic Functions: Common function types in data analysis.

Usage:

Modelling relationships between variables, algorithmic implementations.

Glossary:

Function (f(x)): Relation from inputs to outputs.

8 DISCRETE MATHEMATICS

Concepts & Formulas:

Combinatorics:

Study of counting. E.g., Permutations and Combinations.

Graph Theory:

Study of graphs and networks.

Usage:

Algorithm design, network analysis, complexity analysis.

Glossary:

Graph:

A set of nodes connected by edges.

9 MATRIX COMPUTATIONS IN MACHINE LEARNING

Concepts & Formulas:

Matrix Inversion, Eigenvalue Decomposition: Important for algorithms like PCA.

Usage:

Data transformation, feature extraction.

Glossary:

Matrix Inversion:

Finding a matrix that, when multiplied with the original, yields the identity matrix.