MAHATMA GANDHI UNIVERSITY

Kottayam, Kerala

Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Aloysius College, Edathua					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Deena C Scaria					
Contributors	Dr. Jijo Joy, Dr. Jubin Antony					
Course Name	Probability and Statistics for Data Science and Machine Learning					
Type of Course	DSE					
Specialization title	Data Analytics and Machine Learning					
Course Code	MG3DSEMATA07					
Course Level	200					
Course Summary	This course provides the mathematical foundation in probability and statistics required for Data Science and Machine Learning. It introduces random phenomena, probability models, random variables, distributions, statistical inference, and regression concepts essential for data-driven decision making. The focus is on conceptual understanding, modelling ability, and interpretation rather than heavy theorem proving. Applications are oriented towards data analysis, uncertainty modelling, and learning from data					
Semester	3	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic Set Theory, Functions, Elementary Calculus					

Course Outcomes (CO)

Number of COs		**5**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand fundamental concepts of probability, random variables and Distributions.	U	PO1, PO2, PO3, PO4
2	Apply probability models and standard distributions to real data problems.	A	PO1, PO2, PO3, PO4
3	Analyse statistical data using measures of central tendency, variability and correlation.	An	PO1, PO2, PO3, PO4
4	Use sampling distributions and estimation techniques in data analysis.	A	PO1, PO2, PO3, PO4
5	Interpret results of hypothesis testing and simple regression models in ML contexts	An	PO1, PO2, PO3, PO4, PO5

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

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CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	2	2	-	-	-	-	-	-
CO 2	2	3	2	2	-	-	-	-	-	-
CO 3	3	3	2	2	-	-	-	-	-	-
CO 4	2	3	2	1	-	-	-	-	-	-
CO 5	3	3	2	2	2	-	-	-	-	-

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Foundations of Probability			
	1.1	Random Experiments, Sample Space, Events	3	["1"]
	1.2	Axiomatic Definition of Probability	3	["1"]
	1.3	Conditional Probability and Bayes' Theorem	5	["1"]
	1.4	Independence of Events	4	["2"]
2	Random Variables and Distributions			
	2.1	Discrete Random Variables, PMF, CDF	3	["1"]
	2.2	Continuous Random Variables, PDF	3	["1"]
	2.3	Expectation, Variance, Moments	4	["2"]
	2.4	Important Distributions: Bernoulli, Binomial, Poisson, Uniform, Exponential, Normal	5	["2"]
3	Descriptive Statistics and Correlation			
	3.1	Data Types, Frequency Distributions	3	["3"]
	3.2	Measures of Central Tendency and Dispersion	4	["3"]
	3.3	Skewness and Kurtosis (Concept only)	3	["3"]
	3.4	Covariance and Correlation Coefficient	5	["3", "5"]
4	Statistical Inference and Regression			
	4.1	Sampling, Sampling Distributions (Mean only)	3	["4"]
	4.2	Point Estimation and Confidence Intervals	3	["4"]
	4.3	Basics of Hypothesis Testing (z-test, concept of p value)	5	["5"]
	4.4	Simple Linear Regression and Interpretation	4	["5"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The teaching–learning approach for the course Probability and Statistics for Data Science and Machine Learning integrates lectures with interactive sessions and problem-solving activities. Emphasis is placed on data-based examples and real-world applications to enhance conceptual understanding, analytical thinking, and the ability to interpret statistical results in data science contexts.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests, Assignment/ Seminar, Quiz/Viva **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Theory Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

References

- Sheldon Ross, A First Course in Probability, Pearson. (Module 1 - Chapter 1 – Sections: 1.1–1.6, Chapter 2 – Sections: 2.1–2.5; Module 2 - Chapter 3 – Sections: 3.1–3.6, Chapter 4 – Sections: 4.1–4.5)
- Walpole, Myers, Myers & Ye, Probability and Statistics for Engineers and Scientists, Pearson (Module 3 - Chapter 1 – Sections: 1.1–1.5 , Chapter 2 – Sections: 2.1–2.4; Module 4 - Chapter 6 – Sections: 6.1–6.4, Chapter 8 – Sections: 8.1–8.3)

Suggested Readings

- Blitzstein & Hwang, Introduction to Probability.
- James et al., An Introduction to Statistical Learning.

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SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Aloysius College, Edathua					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Deena C Scaria					
Contributors	Dr. Jijo Joy, Aneesa Asharaf, Athira Murali					
Course Name	Optimization for Data Science					
Type of Course	DSE					
Specialization title	Data Analytics and Machine Learning					
Course Code	MG4DSEMATA07					
Course Level	200					
Course Summary	This course introduces optimization techniques with applications in data science. Students learn about convex sets, linear programming, simplex and duality theory, classical optimization, nonlinear programming algorithms, and gradient-based methods. Practical applications using Excel Solver is integrated to support computational understanding.					
Semester	4	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Basic knowledge of Differential Calculus (Partial Derivatives), Matrices and system of linear equations.					

Course Outcomes (CO)

Number of COs		**7**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Explain and apply geometric concepts of convexity including convex sets, hyper planes to analyze feasible regions in optimization problems.	U	PO1, PO2
2	Formulate linear programming problems and determine feasible region, basic solutions and optimal solutions using graphical methods.	A	PO1, PO2
3	Solve linear programming problems using the Simplex method.	A, An	PO1, PO2
4	Construct and solve dual problems and analyze the relationship between primal and dual solutions.	An, E	PO1, PO2, PO3
5	Apply necessary and sufficient conditions to solve unconstrained and constrained optimization problems using Newton’s method and Lagrange multipliers.	A, An	PO1, PO2
6	Analyze and implement gradient-based and direct search algorithms for nonlinear optimization problems in data science contexts.	An	PO1, PO2, PO3

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Number of COs		7	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
7	Implement optimization technique computationally using Excel Solver to obtain and interpret optimal solutions for linear and nonlinear models.	A, E, S	PO2, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	-	-	-	-	-	-	-
CO 2	3	3	-	-	-	-	-	-	-	-
CO 3	3	3	-	-	-	-	-	-	-	-
CO 4	2	3	2	-	-	-	-	-	-	-
CO 5	3	3	-	-	-	-	-	-	-	-
CO 6	3	3	2	-	-	-	-	-	-	-
CO 7	-	3	-	-	-	-	-	-	-	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Foundations of Convexity & Linear Programming			
	1.1	Convex Sets and Convex Hull	2	["1"]
	1.2	Hyper Planes and Polytopes	3	["1"]
	1.3	Formulation of LP problems	4	["2"]
	1.4	Graphical method, Basic feasible solutions and optimality	6	["2"]
2	Advanced Linear Programming & Duality			
	2.1	Standard form of LP and Simplex method	3	["3"]
	2.2	Degeneracy and Simplex Multipliers	3	["3"]
	2.3	Dual problem and duality theorems	4	["4"]
	2.4	Dual Simplex Method	5	["4"]
3	Classical & Algorithmic Optimization			
	3.1	Unconstrained Optimization- Newton Raphson Method	3	["5"]
	3.2	Constrained Optimization, KKT Conditions	5	["5"]
	3.3	Unconstrained Algorithm – Direct Search Method	4	["6"]
	3.4	Gradient Method	3	["6"]

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Module	Units	Course Description	Hrs	CO No.
4	Applications of Excel in Optimization and Numerical Analysis			
	4.1	Formulation of LP problem in Excel & Solving LP using Excel Solver.	7	["7"]
	4.2	Solve Excel for numerical verification of Newton Raphson, KKT conditions etc.	8	["7"]

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The teaching–learning approach emphasizes practical, application-oriented learning supported by lectures and interactive discussions. A key focus is on hands-on practical sessions using tools such as Excel Solver, where students formulate and solve optimization problems, verify theoretical results, and interpret solutions in real-world contexts. This integration of computational tools enhances problem-solving skills and strengthens the connection between theory and practice.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests, Assignment/ Seminar, Practical **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Theory Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

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References

- K. V Mital and C Mohan, Optimization Methods in Operations Research and System Analysis (3rd Edition), New Age International 1996. (Module 1- Chapter 1 – Sections: 11 to 16, Chapter 3 -Sections: 1 to 7 ; Module 2- Chapter 3 - Sections: 9 to 20 (except 16) (Statements of theorems only))
- Hamdy A, Taha, Operations Research: An Introduction (10th Edition), Pearson Education Limited 2012. (Module 3 - Chapter 20 Sections: 20.1 & 20.2, Chapter 21- Section: 21.1(Statements of theorems only))
- For Practical sessions, refer to the relevant sections of the above two textbooks.

Suggested Readings

- J. K. Sharma, Operation Research Theory and Application (3rd Edition), 2006.
- Ravindran, Philips, Solberg, Operations Research Principles and Practice; 2nd Edition, Wiley India Publishers, 2012.
- Kanti Swarup, Gupta, P.K., Man Mohan, Operation Research, S Chand & Sons Publications.

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Undergraduate Programmes (HONOURS)
2025 Admission Onwards

SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Aloysius College, Edathua					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Deena C Scaria					
Contributors	Dr. Deena C Scaria, Anu Souriar, Harikrishnan M R					
Course Name	Computational Linear Algebra for Data Science					
Type of Course	DSE					
Specialization title	Data Analytics and Machine Learning					
Course Code	MG5DSEMATA07					
Course Level	300					
Course Summary	This course covers fundamental concepts of linear algebra including vectors, inner product spaces, linear dependence, bases, and orthonormalization. It also introduces vector spaces, linear transformations, matrix representation, and least squares methods, with emphasis on both theory and applications.					
Semester	5	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Matrix, Matrix Operations					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Understand and apply the fundamental concepts of vectors, inner product spaces, norms, and orthogonality to solve geometrical and algebraic problems.	U, A	PO1, PO2, PO4
2	Analyze linear dependence, basis, dimension, and construct orthonormal sets using Gram–Schmidt process to represent vector spaces effectively.	U, An	PO1, PO2, PO3, PO4
3	Demonstrate understanding of vector spaces and linear transformations, and represent linear maps using matrices and perform related computations.	U, E	PO1, PO2, PO3, PO4
4	Apply linear algebra techniques such as matrix representation and least squares methods to solve real-world and computational problems	A, E	PO1, PO2, PO3, PO4, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

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CO-PO Articulation Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	-	1	-	-	-	-	-	-
CO 2	2	3	2	2	-	-	-	-	-	-
CO 3	2	2	2	3	-	-	-	-	-	-
CO 4	3	3	2	2	-	-	-	-	-	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Vectors			
	1.1	Vectors	3	["1"]
	1.2	Vector addition and Scalar multiplication	4	["1"]
	1.3	Inner Product	4	["1"]
	1.4	Norms	4	["1"]
2	Linear Independence			
	2.1	Linear Dependence	3	["2"]
	2.2	Basis	4	["2"]
	2.3	Orthonormal vectors	3	["2"]
	2.4	Gram-Schmidt algorithm	5	["2"]
3	Linear Maps			
	3.1	Vector space	3	["3"]
	3.2	Definition and Examples of Linear Maps	3	["3"]
	3.3	Representing a Linear Map by a Matrix	4	["3"]
	3.4	Linear Maps thought of as Matrix Multiplication	5	["3"]
4	Least Squares			
	4.1	Least Squares Problems	4	["4"]
	4.2	Solving Least Squares Problems	6	["4"]
	4.3	Least Square Classification	5	["4"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The teaching–learning approach is lecture-based and supported by interactive discussions, seminars, and ICT tools. It also includes problem-solving sessions and application-oriented examples to enhance conceptual understanding and analytical skills, with opportunities for student participation through presentations and discussions.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests, Assignment / Seminar, Quiz / Viva **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Theory Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ∘ PART - A ∘ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ∘ PART - B ∘ Short answer - (5 out of 8) – 5 × 6 = 30 ∘ PART - C ∘ Essays - (3 out of 6) – 3 × 10 = 30

References

- Boyd S, Vandenberghe L, Introduction to Applied Linear Algebra, Cambridge University Press, 2018. (Module 1 - Chapter 1 - Sections: 1.1, 1.2, 1.3 & 1.4 ,Chapter 3 – Section: 3.1; Module 2 - Chapter 5 - Sections: 5.1, 5.2, 5.3 & 5.4 ; Module 4 - Chapter 12 - Sections: 12.1, 12.2, & 12.3, Chapter 14 – Section: 14.1)
- Sheldon Axler, Linear Algebra Done Right (3rd ed.), Springer, 2015. (Module 3 - Chapter 1 - Section: 1B, Chapter 3 – Sections: 3A, 3C & 3D)

Suggested Readings

- Gilbert Strang, Introduction to Linear Algebra (5th ed.), Wellesley-Cambridge Press, 2016.
- David C Lay, Linear Algebra and its Applications (5th ed.), Pearson Education, 2018.
- Hoffman K, Kunze R, Linear Algebra (2nd ed.), Prentice Hall, 2009.
- M. Thamban Nair, Arindama Singh, Linear Algebra, Springer, 2018.
- S. Kumaresan, Linear Algebra: A Geometric Approach, PHI Learning, 2015.

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SYLLABUS						
SIGNATURE COURSE						
Name of the College	St. Aloysius College, Edathua					
Faculty/ Discipline	Mathematics					
Programme	BSc (Hons) Mathematics					
Course Coordinator	Deena C Scaria					
Contributors	Dr. Jubin Antony, Dr. Jijo Joy					
Course Name	Machine Learning Algorithms					
Type of Course	DSE					
Specialization title	Data Analytics and Machine Learning					
Course Code	MG6DSEMATA07					
Course Level	300					
Course Summary	This course gives an introduction to machine learning and the board areas of machine learning namely Supervised and Unsupervised Learning. The course helps the students to gain practical skills in data processing, feature engineering, and algorithm selection. The theoretical learning is supplemented with practical sessions in Python.					
Semester	6	**Credits**			4	**Total Hours**
Course Details	**Learning Approach**	Lecture	Tutorial	Practical	Others	
		4	0	0	0	60
Pre-requisites, if any	Nil					

Course Outcomes (CO)

Number of COs		**4**	
CO No.	**Expected Course Outcome**	**Learning Domains ***	**PO No**
1	Develop a good understanding of fundamental principles of machine learning.	U	PO1, PO2
2	Develop supervised learning algorithms for regression and classification problems.	A	PO2, PO3
3	Analyze and implement unsupervised learning techniques for pattern discovery.	An	PO2, PO3
4	Evaluate performance of various machine learning algorithms.	A	PO1, PO2, PO3, PO10

**Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)*

CO-PO Articulation Matrix

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CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	-	-	-	-	-	-	-	-
CO 2	-	3	2	-	-	-	-	-	-	-
CO 3	-	3	3	-	-	-	-	-	-	-
CO 4	1	2	3	-	-	-	-	-	-	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Course Content

Content for Classroom transaction (Units)

Module	Units	Course Description	Hrs	CO No.
1	Foundations of Machine Learning & Model Preparation			
	1.1	Types of human learning. What is machine learning? Need for Machine Learning. Applications of machine learning	3	["1"]
	1.2	Types of machine learning– supervised, unsupervised, semi-supervised and reinforcement learning. Machine learning process.	4	["1"]
	1.3	Types of data in machine learning, Exploring structure of data, Data preprocessing	4	["1"]
	1.4	Feature engineering	4	["1"]
2	Supervised Learning Algorithms			
	2.1	Regression Models: Simple Linear regression, Multiple Linear regression, Validation of regression models	4	["2"]
	2.2	Classification Algorithms: k-NN, Logistic regression	4	["2"]
	2.3	Advanced Supervised Methods: Decision trees, Random Forest Method	4	["2"]
	2.4	Bayesian Learning	3	["2"]
3	Unsupervised Learning Algorithms			
	3.1	Clustering Algorithms	3	["3"]
	3.2	k-means clustering	4	["3"]
	3.3	DBSCAN (overview)	4	["3"]
	3.4	Artificial Neural Networks	4	["3"]
4	Performance Evaluation			
	4.1	Basic Performance Criteria	5	["4"]
	4.2	Precision and Recall	5	["4"]
	4.3	Learning Curve and Computational costs	5	["4"]

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Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** The teaching–learning approach for the course Machine Learning Algorithms integrates lectures with interactive instruction, seminars, group discussions, and group-based activities, along with library work to encourage independent exploration of concepts and recent developments. A strong emphasis is placed on practical methods using Python, where students actively engage in hands-on implementation of algorithms, data preprocessing, and visualization. Through collaborative learning and guided library research, students are able to connect theory with real-world applications. This approach enhances computational skills, model-building ability, critical thinking, and a deeper understanding of machine learning techniques.

Assessment Types	**MODE OF ASSESSMENT** Mode of Assessment: Theory **A. Continuous Comprehensive Assessment (CCA)** **• Theory – 30 Marks** Module Tests, Assignment/ Seminar, Practical **B. End Semester Evaluation (ESE)** **• Theory – 70 Marks** Assessment Methods – Theory Examination Duration of Examination – 2.00 Hrs Pattern of examination for Theory – Non-MCQ Different parts of written examination – Part - A , B , C Answer Type: ◦ PART - A ◦ One or two Sentences - (5 out of 8) – 5 × 2 = 10 ◦ PART - B ◦ Short answer - (5 out of 8) – 5 × 6 = 30 ◦ PART - C ◦ Essays - (3 out of 6) – 3 × 10 = 30

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References

- S Sridhar, M Vijayalakshmi, Machine Learning, Oxford University Press, 2021. (Module 1 -Sections: 1.1 to 1.6, Sections: 2.1 to 2.3 ; Module 2 - Sections: 5.1 to 5.5, Sections: 4.1 to 4.3, Section: 6.1.1, Sections: 8.1 to 8.3; Module 3 - Sections: 10.1 to 10.3 & 13.1 to 13.5)
- Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Machine Learning, Pearson. (Module 1 - Section: 4.1; Module 2 - Section: 7.5.3)
- Miroslav¬Kubat, An Introduction to Machine Learning, Springer Second Edition 2017.(Module 4 - Sections: 11.1, 11.2 & 11.4)
- Andreas C. Müller, Sarah Guido, Introduction to Machine Learning with Python A Guide for Data Scientists, O'Reilly Media, Inc 2016.
- Pratap Dangeti, Statistics for Machine Learning Techniques for exploring supervised, unsupervised, and reinforcement learning models with Python and R, Packt Publishing (1st edition) 2017.

Suggested Readings

- Tom M. Mitchell, Machine Learning, McGraw-Hill Education, 2013.
- M N Murty, Ananthanarayana V S, Machine Learning: Theory and Practice, Universities Press (India) Pvt. Limited, 2024.
- Miroslav Kubat, An Introduction to Machine Learning, Springer, 2017.

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