

Contents

Preface	xix
Section 1: Theoretical Fundamentals	1
1 Mathematical Foundation	3
<i>Afroz and Basharat Hussain</i>	
1.1 Concept of Linear Algebra	3
1.1.1 Introduction	3
1.1.2 Vector Spaces	5
1.1.3 Linear Combination	6
1.1.4 Linearly Dependent and Independent Vectors	7
1.1.5 Linear Span, Basis and Subspace	8
1.1.6 Linear Transformation (or Linear Map)	9
1.1.7 Matrix Representation of Linear Transformation	10
1.1.8 Range and Null Space of Linear Transformation	13
1.1.9 Invertible Linear Transformation	15
1.2 Eigenvalues, Eigenvectors, and Eigendecomposition of a Matrix	15
1.2.1 Characteristics Polynomial	16
1.2.1.1 Some Results on Eigenvalue	16
1.2.2 Eigendecomposition	18
1.3 Introduction to Calculus	20
1.3.1 Function	20
1.3.2 Limits of Functions	21
1.3.2.1 Some Properties of Limits	22
1.3.2.2 Infinite Limits	25
1.3.2.3 Limits at Infinity	26
1.3.3 Continuous Functions and Discontinuous Functions	26
1.3.3.1 Discontinuous Functions	27
1.3.3.2 Properties of Continuous Function	27
1.3.4 Differentiation	28
References	29

2	Theory of Probability	31
	<i>Parvaze Ahmad Dar and Afroz</i>	
2.1	Introduction	31
2.1.1	Definition	31
	2.1.1.1 Statistical Definition of Probability	31
	2.1.1.2 Mathematical Definition of Probability	32
2.1.2	Some Basic Terms of Probability	32
	2.1.2.1 Trial and Event	32
	2.1.2.2 Exhaustive Events (Exhaustive Cases)	33
	2.1.2.3 Mutually Exclusive Events	33
	2.1.2.4 Equally Likely Events	33
	2.1.2.5 Certain Event or Sure Event	33
	2.1.2.6 Impossible Event or Null Event (ϕ)	33
	2.1.2.7 Sample Space	34
	2.1.2.8 Permutation and Combination	34
	2.1.2.9 Examples	35
2.2	Independence in Probability	38
	2.2.1 Independent Events	38
	2.2.2 Examples: Solve the Following Problems	38
2.3	Conditional Probability	41
	2.3.1 Definition	41
	2.3.2 Mutually Independent Events	42
	2.3.3 Examples	42
2.4	Cumulative Distribution Function	43
	2.4.1 Properties	44
	2.4.2 Example	44
2.5	Baye's Theorem	46
	2.5.1 Theorem	46
	2.5.1.1 Examples	47
2.6	Multivariate Gaussian Function	50
	2.6.1 Definition	50
	2.6.1.1 Univariate Gaussian (i.e., One Variable Gaussian)	50
	2.6.1.2 Degenerate Univariate Gaussian	51
	2.6.1.3 Multivariate Gaussian	51
	References	51
3	Correlation and Regression	53
	<i>Mohd. Abdul Haleem Rizwan</i>	
3.1	Introduction	53

3.2	Correlation	54
3.2.1	Positive Correlation and Negative Correlation	54
3.2.2	Simple Correlation and Multiple Correlation	54
3.2.3	Partial Correlation and Total Correlation	54
3.2.4	Correlation Coefficient	55
3.3	Regression	57
3.3.1	Linear Regression	64
3.3.2	Logistic Regression	64
3.3.3	Polynomial Regression	65
3.3.4	Stepwise Regression	66
3.3.5	Ridge Regression	67
3.3.6	Lasso Regression	67
3.3.7	Elastic Net Regression	68
3.4	Conclusion	68
	References	69

Section 2: Big Data and Pattern Recognition **71**

4	Data Preprocess	73
	<i>Md. Sharif Hossen</i>	
4.1	Introduction	73
4.1.1	Need of Data Preprocessing	74
4.1.2	Main Tasks in Data Preprocessing	75
4.2	Data Cleaning	77
4.2.1	Missing Data	77
4.2.2	Noisy Data	78
4.3	Data Integration	80
4.3.1	χ^2 Correlation Test	82
4.3.2	Correlation Coefficient Test	82
4.3.3	Covariance Test	83
4.4	Data Transformation	83
4.4.1	Normalization	83
4.4.2	Attribute Selection	85
4.4.3	Discretization	86
4.4.4	Concept Hierarchy Generation	86
4.5	Data Reduction	88
4.5.1	Data Cube Aggregation	88
4.5.2	Attribute Subset Selection	90
4.5.3	Numerosity Reduction	91
4.5.4	Dimensionality Reduction	95
4.6	Conclusion	101

6	Pattern Recognition Concepts	131
	<i>Ambeshwar Kumar, R. Manikandan and C. Thaventhiran</i>	
6.1	Classifier	132
6.1.1	Introduction	132
6.1.2	Explanation-Based Learning	133
6.1.3	Isomorphism and Clique Method	135
6.1.4	Context-Dependent Classification	138
6.1.5	Summary	139
6.2	Feature Processing	140
6.2.1	Introduction	140
6.2.2	Detection and Extracting Edge With Boundary Line	141
6.2.3	Analyzing the Texture	142
6.2.4	Feature Mapping in Consecutive Moving Frame	143
6.2.5	Summary	145
6.3	Clustering	145
6.3.1	Introduction	145
6.3.2	Types of Clustering Algorithms	146
6.3.2.1	Dynamic Clustering Method	148
6.3.2.2	Model-Based Clustering	148
6.3.3	Application	149
6.3.4	Summary	150
6.4	Conclusion	151
	References	151

Section 3: Machine Learning: Algorithms & Applications **153**

7	Machine Learning	155
	<i>Elham Ghanbari and Sara Najafzadeh</i>	
7.1	History and Purpose of Machine Learning	155
7.1.1	History of Machine Learning	155
7.1.1.1	What is Machine Learning?	156
7.1.1.2	When the Machine Learning is Needed?	157
7.1.2	Goals and Achievements in Machine Learning	158
7.1.3	Applications of Machine Learning	158
7.1.3.1	Practical Machine Learning Examples	159
7.1.4	Relation to Other Fields	161
7.1.4.1	Data Mining	161
7.1.4.2	Artificial Intelligence	162
7.1.4.3	Computational Statistics	162
7.1.4.4	Probability	163

7.1.5	Limitations of Machine Learning	163
7.2	Concept of Well-Defined Learning Problem	164
7.2.1	Concept Learning	164
7.2.1.1	Concept Representation	166
7.2.1.2	Instance Representation	167
7.2.1.3	The Inductive Learning Hypothesis	167
7.2.2	Concept Learning as Search	167
7.2.2.1	Concept Generality	168
7.3	General-to-Specific Ordering Over Hypotheses	169
7.3.1	Basic Concepts: Hypothesis, Generality	169
7.3.2	Structure of the Hypothesis Space	169
7.3.2.1	Hypothesis Notations	169
7.3.2.2	Hypothesis Evaluations	170
7.3.3	Ordering on Hypotheses: General to Specific	170
7.3.3.1	Most Specific Generalized	171
7.3.3.2	Most General Specialized	173
7.3.3.3	Generalization and Specialization Operators	173
7.3.4	Hypothesis Space Search by Find-S Algorithm	174
7.3.4.1	Properties of the Find-S Algorithm	176
7.3.4.2	Limitations of the Find-S Algorithm	176
7.4	Version Spaces and Candidate Elimination Algorithm	177
7.4.1	Representing Version Spaces	177
7.4.1.1	General Boundary	178
7.4.1.2	Specific Boundary	178
7.4.2	Version Space as Search Strategy	179
7.4.3	The List-Eliminate Method	179
7.4.4	The Candidate-Elimination Method	180
7.4.4.1	Example	181
7.4.4.2	Convergence of Candidate-Elimination Method	183
7.4.4.3	Inductive Bias for Candidate-Elimination	184
7.5	Concepts of Machine Learning Algorithm	185
7.5.1	Types of Learning Algorithms	185
7.5.1.1	Incremental vs. Batch Learning Algorithms	186
7.5.1.2	Offline vs. Online Learning Algorithms	188
7.5.1.3	Inductive vs. Deductive Learning Algorithms	189
7.5.2	A Framework for Machine Learning Algorithms	189
7.5.2.1	Training Data	190
7.5.2.2	Target Function	190
7.5.2.3	Construction Model	191

7.5.2.4	Evaluation	191
7.5.3	Types of Machine Learning Algorithms	194
7.5.3.1	Supervised Learning	196
7.5.3.2	Unsupervised Learning	198
7.5.3.3	Semi Supervised Learning	200
7.5.3.4	Reinforcement Learning	200
7.5.3.5	Deep Learning	202
7.5.4	Types of Machine Learning Problems	203
7.5.4.1	Classification	204
7.5.4.2	Clustering	204
7.5.4.3	Optimization	205
7.5.4.4	Regression	205
	Conclusion	205
	References	206
8	Performance of Supervised Learning Algorithms on Multi-Variate Datasets	209
	<i>Asif Iqbal Hajamydeen and Rabab Alayham Abbas Helmi</i>	
8.1	Introduction	209
8.2	Supervised Learning Algorithms	210
8.2.1	Datasets and Experimental Setup	211
8.2.2	Data Treatment/Preprocessing	212
8.3	Classification	212
8.3.1	Support Vector Machines (SVM)	213
8.3.2	Naïve Bayes (NB) Algorithm	214
8.3.3	Bayesian Network (BN)	214
8.3.4	Hidden Markov Model (HMM)	215
8.3.5	K-Nearest Neighbour (KNN)	216
8.3.6	Training Time	216
8.4	Neural Network	217
8.4.1	Artificial Neural Networks Architecture	219
8.4.2	Application Areas	222
8.4.3	Artificial Neural Networks and Time Series	224
8.5	Comparisons and Discussions	225
8.5.1	Comparison of Classification Accuracy	225
8.5.2	Forecasting Efficiency Comparison	226
8.5.3	Recurrent Neural Network (RNN)	226
8.5.4	Backpropagation Neural Network (BPNN)	228
8.5.5	General Regression Neural Network	229
8.6	Summary and Conclusion	230
	References	231

9	Unsupervised Learning	233
	<i>M. Kumara Swamy and Tejaswi Puligilla</i>	
9.1	Introduction	233
9.2	Related Work	234
9.3	Unsupervised Learning Algorithms	235
9.4	Classification of Unsupervised Learning Algorithms	238
9.4.1	Hierarchical Methods	238
9.4.2	Partitioning Methods	239
9.4.3	Density-Based Methods	242
9.4.4	Grid-Based Methods	245
9.4.5	Constraint-Based Clustering	245
9.5	Unsupervised Learning Algorithms in ML	246
9.5.1	Parametric Algorithms	246
9.5.2	Non-Parametric Algorithms	246
9.5.3	Dirichlet Process Mixture Model	247
9.5.4	X-Means	248
9.6	Summary and Conclusions	248
	References	248
10	Semi-Supervised Learning	251
	<i>Manish Deygan, Gaurav Malik and Deepak Kumar Sharma</i>	
10.1	Introduction	252
10.1.1	Semi-Supervised Learning	252
10.1.2	Comparison With Other Paradigms	255
10.2	Training Models	257
10.2.1	Self-Training	257
10.2.2	Co-Training	259
10.3	Generative Models—Introduction	261
10.3.1	Image Classification	264
10.3.2	Text Categorization	266
10.3.3	Speech Recognition	268
10.3.4	Baum-Welch Algorithm	268
10.4	S3VMs	270
10.5	Graph-Based Algorithms	274
10.5.1	Mincut	275
10.5.2	Harmonic	276
10.5.3	Manifold Regularization	277
10.6	Multiview Learning	277
10.7	Conclusion	278
	References	279

11 Reinforcement Learning	281
<i>Amandeep Singh Bhatia, Mandeep Kaur Saggi, Amit Sundas and Jatinder Ashta</i>	
11.1 Introduction: Reinforcement Learning	281
11.1.1 Elements of Reinforcement Learning	283
11.2 Model-Free RL	284
11.2.1 Q-Learning	285
11.2.2 R-Learning	286
11.3 Model-Based RL	287
11.3.1 SARSA Learning	289
11.3.2 Dyna-Q Learning	290
11.3.3 Temporal Difference	291
11.3.3.1 TD(0) Algorithm	292
11.3.3.2 TD(1) Algorithm	293
11.3.3.3 TD(λ) Algorithm	294
11.3.4 Monte Carlo Method	294
11.3.4.1 Monte Carlo Reinforcement Learning	296
11.3.4.2 Monte Carlo Policy Evaluation	296
11.3.4.3 Monte Carlo Policy Improvement	298
11.4 Conclusion	298
References	299
12 Application of Big Data and Machine Learning	305
<i>Neha Sharma, Sunil Kumar Gautam, Azriel A. Henry and Abhimanyu Kumar</i>	
12.1 Introduction	306
12.2 Motivation	307
12.3 Related Work	308
12.4 Application of Big Data and ML	309
12.4.1 Healthcare	309
12.4.2 Banking and Insurance	312
12.4.3 Transportation	314
12.4.4 Media and Entertainment	316
12.4.5 Education	317
12.4.6 Ecosystem Conservation	319
12.4.7 Manufacturing	321
12.4.8 Agriculture	322
12.5 Issues and Challenges	324
12.6 Conclusion	326
References	326

Section 4: Machine Learning's Next Frontier	335
13 Transfer Learning	337
<i>Riyanshi Gupta, Kartik Krishna Bhardwaj and Deepak Kumar Sharma</i>	
13.1 Introduction	338
13.1.1 Motivation, Definition, and Representation	338
13.2 Traditional Learning vs. Transfer Learning	338
13.3 Key Takeaways: Functionality	340
13.4 Transfer Learning Methodologies	341
13.5 Inductive Transfer Learning	342
13.6 Unsupervised Transfer Learning	344
13.7 Transductive Transfer Learning	346
13.8 Categories in Transfer Learning	347
13.9 Instance Transfer	348
13.10 Feature Representation Transfer	349
13.11 Parameter Transfer	349
13.12 Relational Knowledge Transfer	350
13.13 Relationship With Deep Learning	351
13.13.1 Transfer Learning in Deep Learning	351
13.13.2 Types of Deep Transfer Learning	352
13.13.3 Adaptation of Domain	352
13.13.4 Domain Confusion	353
13.13.5 Multitask Learning	354
13.13.6 One-Shot Learning	354
13.13.7 Zero-Shot Learning	355
13.14 Applications: Allied Classical Problems	355
13.14.1 Transfer Learning for Natural Language Processing	356
13.14.2 Transfer Learning for Computer Vision	356
13.14.3 Transfer Learning for Audio and Speech	357
13.15 Further Advancements and Conclusion	357
References	358
Section 5: Hands-On and Case Study	361
14 Hands on MAHOUT—Machine Learning Tool	
<i>Uma N. Dulhare and Sheikh Gouse</i>	
14.1 Introduction to Mahout	363
14.1.1 Features	366
14.1.2 Advantages	366
14.1.3 Disadvantages	366

14.1.4	Application	366
14.2	Installation Steps of Apache Mahout Using Cloudera	367
14.2.1	Installation of VMware Workstation	367
14.2.2	Installation of Cloudera	368
14.2.3	Installation of Mahout	383
14.2.4	Installation of Maven	384
14.2.5	Testing Mahout	386
14.3	Installation Steps of Apache Mahout Using Windows 10	386
14.3.1	Installation of Java	386
14.3.2	Installation of Hadoop	387
14.3.3	Installation of Mahout	387
14.3.4	Installation of Maven	387
14.3.5	Path Setting	388
14.3.6	Hadoop Configuration	391
14.4	Installation Steps of Apache Mahout Using Eclipse	395
14.4.1	Eclipse Installation	395
14.4.2	Installation of Maven Through Eclipse	396
14.4.3	Maven Setup for Mahout Configuration	399
14.4.4	Building the Path-	402
14.4.5	Modifying the pom.xml File	405
14.4.6	Creating the Data File	407
14.4.7	Adding External Jar Files	408
14.4.8	Creating the New Package and Classes	410
14.4.9	Result	411
14.5	Mahout Algorithms	412
14.5.1	Classification	412
14.5.2	Clustering	413
14.5.3	Recommendation	415
14.6	Conclusion	418
	References	418
15	Hands-On H2O Machine Learning Tool	423
	<i>Uma N. Dulhare, Azmath Mubeen and Khaleel Ahmed</i>	
15.1	Introduction	424
15.2	Installation	425
	15.2.1 The Process of Installation	425
15.3	Interfaces	431
15.4	Programming Fundamentals	432
	15.4.1 Data Manipulation	432
	15.4.1.1 Data Types	432
	15.4.1.2 Data Import	435

15.4.2	Models	436
15.4.2.1	Model Training	436
15.4.3	Discovering Aspects	437
15.4.3.1	Converting Data Frames	437
15.4.4	H2O Cluster Actions	438
15.4.4.1	H2O Key Value Retrieval	438
15.4.4.2	H2O Cluster Connection	438
15.4.5	Commands	439
15.4.5.1	Cluster Information	439
15.4.5.2	General Data Operations	441
15.4.5.3	String Manipulation Commands	442
15.5	Machine Learning in H2O	442
15.5.1	Supervised Learning	442
15.5.2	Unsupervised Learning	443
15.6	Applications of H2O	443
15.6.1	Deep Learning	443
15.6.2	K-Fold Cross-Authentication or Validation	448
15.6.3	Stacked Ensemble and Random Forest Estimator	450
15.7	Conclusion	452
	References	453
16	Case Study: Intrusion Detection System Using Machine Learning	455
	<i>Syeda Hajra Mahin, Fahmina Taranum and Reshma Nikhat</i>	
16.1	Introduction	456
16.1.1	Components Used to Design the Scenario Include	456
16.1.1.1	Black Hole	456
16.1.1.2	Intrusion Detection System	457
16.1.1.3	Components Used From MATLAB Simulator	458
16.2	System Design	465
16.2.1	Three Sub-Network Architecture	465
16.2.2	Using Classifiers of MATLAB	465
16.3	Existing Proposals	467
16.4	Approaches Used in Designing the Scenario	469
16.4.1	Algorithm Used in QualNet	469
16.4.2	Algorithm Applied in MATLAB	471
16.5	Result Analysis	471
16.5.1	Results From QualNet	471
16.5.1.1	Deployment	471
16.5.1.2	Detection	472

16.5.1.3	Avoidance	473
16.5.1.4	Validation of Conclusion	473
16.5.2	Applying Results to MATLAB	473
16.5.2.1	K-Nearest Neighbor	475
16.5.2.2	SVM	477
16.5.2.3	Decision Tree	477
16.5.2.4	Naïve Bayes	479
16.5.2.5	Neural Network	479
16.6	Conclusion	484
	References	484
17	Inclusion of Security Features for Implications of Electronic Governance Activities	487
	<i>Prabal Pratap and Nripendra Dwivedi</i>	
17.1	Introduction	487
17.2	Objective of E-Governance	491
17.3	Role of Identity in E-Governance	493
17.3.1	Identity	493
17.3.2	Identity Management and its Buoyancy Against Identity Theft in E-Governance	494
17.4	Status of E-Governance in Other Countries	496
17.4.1	E-Governance Services in Other Countries Like Australia and South Africa	496
17.4.2	Adaptation of Processes and Methodology for Developing Countries	496
17.4.3	Different Programs Related to E-Governance	499
17.5	Pros and Cons of E-Governance	501
17.6	Challenges of E-Governance in Machine Learning	502
17.7	Conclusion	503
	References	503
	Index	505