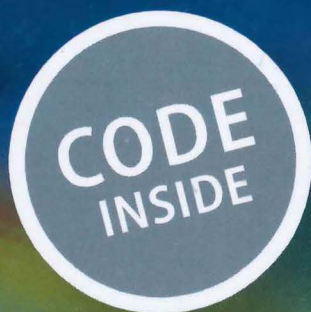


TEXTBOOK

Amin Zollanvari

Machine Learning with Python

Theory and Implementation



 Springer

สำนักหอสมุด มหาวิทยาลัยเชียงใหม่

6 16408772
012545975
1 2268490

Amin Zollanvari

Machine Learning with Python

Theory and Implementation



 Springer

Contents

Preface	vii
About This Book	ix
1 Introduction	1
1.1 General Concepts.....	1
1.1.1 Machine Learning.....	1
1.1.2 Supervised Learning.....	2
1.1.3 Unsupervised Learning.....	3
1.1.4 Semi-supervised Learning.....	5
1.1.5 Reinforcement Learning.....	5
1.1.6 Design Process.....	6
1.1.7 Artificial Intelligence.....	7
1.2 What Is “Learning” in Machine Learning?.....	7
1.3 An Illustrative Example.....	9
1.3.1 Data.....	9
1.3.2 Feature Selection.....	9
1.3.3 Feature Extraction.....	10
1.3.4 Segmentation.....	12
1.3.5 Training.....	15
1.3.6 Evaluation.....	16
1.4 Python in Machine Learning and Throughout This Book.....	17
2 Getting Started with Python	21
2.1 First Things First: Installing What Is Needed.....	21
2.2 Jupyter Notebook.....	23
2.3 Variables.....	24
2.4 Strings.....	25
2.5 Some Important Operators.....	26
2.5.1 Arithmetic Operators.....	26
2.5.2 Relational and Logical Operators.....	26
2.5.3 Membership Operators.....	27
2.6 Built-in Data Structures.....	27
2.6.1 Lists.....	27
2.6.2 Tuples.....	33

2.6.3	Dictionaries	36
2.6.4	Sets	38
2.6.5	Some Remarks on Sequence Unpacking	39
2.7	Flow of Control and Some Python Idioms	41
2.7.1	for Loops	41
2.7.2	List Comprehension	45
2.7.3	if-elif-else	47
2.8	Function, Module, Package, and Alias	47
2.8.1	Functions	47
2.8.2	Modules and Packages	49
2.8.3	Aliases	51
2.9	⊕ Iterator, Generator Function, and Generator Expression	52
2.9.1	Iterator	52
2.9.2	Generator Function	53
2.9.3	Generator Expression	57
3	Three Fundamental Python Packages	63
3.1	NumPy	63
3.1.1	Working with NumPy Package	63
3.1.2	NumPy Array Attributes	65
3.1.3	NumPy Built-in Functions for Array Creation	67
3.1.4	Array Indexing	69
3.1.5	Reshaping Arrays	73
3.1.6	Universal Functions (UFuncs)	75
3.1.7	Broadcasting	77
3.2	Pandas	81
3.2.1	Series	81
3.2.2	DataFrame	86
3.2.3	Pandas Read and Write Data	93
3.3	Matplotlib	94
3.3.1	Backend and Frontend	94
3.3.2	The Two matplotlib Interfaces: pyplot-style and OO-style	94
3.3.3	Two Instructive Examples	99
4	Supervised Learning in Practice: the First Application Using Scikit-Learn	111
4.1	Supervised Learning	111
4.2	Scikit-Learn	112
4.3	The First Application: Iris Flower Classification	113
4.4	Test Set for Model Assessment	116
4.5	Data Visualization	117
4.6	Feature Scaling (Normalization)	118
4.7	Model Training	123
4.8	Prediction Using the Trained Model	125
4.9	Model Evaluation (Error Estimation)	126

5	k-Nearest Neighbors	133
5.1	Classification	133
5.1.1	Standard kNN Classifier	133
5.1.2	Distance-Weighted kNN Classifier	136
5.1.3	The Choice of Distance	138
5.2	Regression	138
5.2.1	Standard kNN Regressor	138
5.2.2	A Regression Application Using kNN	139
5.2.3	Distance-Weighted kNN Regressor	146
6	Linear Models	151
6.1	Optimal Classification	151
6.1.1	Discriminant Functions and Decision Boundaries	152
6.1.2	Bayes Classifier	152
6.2	Linear Models for Classification	154
6.2.1	Linear Discriminant Analysis	155
6.2.2	Logistic Regression	162
6.3	Linear Models for Regression	176
7	Decision Trees	187
7.1	A Mental Model for House Price Classification	187
7.2	CART Development for Classification:	191
7.2.1	Splits	191
7.2.2	Splitting Strategy	192
7.2.3	Classification at Leaf Nodes	193
7.2.4	Impurity Measures	194
7.2.5	Handling Weighted Samples	196
7.3	CART Development for Regression	197
7.3.1	Differences Between Classification and Regression	197
7.3.2	Impurity Measures	197
7.3.3	Regression at Leaf Nodes	198
7.4	Interpretability of Decision Trees	202
8	Ensemble Learning	209
8.1	A General Perspective on the Efficacy of Ensemble Learning	209
8.1.1	Bias-Variance Decomposition	210
8.1.2	\oplus How Would Ensemble Learning Possibly Help?	212
8.2	Stacking	215
8.3	Bagging	216
8.4	Random Forest	217
8.5	Pasting	219
8.6	Boosting	220
8.6.1	AdaBoost	220
8.6.2	\oplus Gradient Boosting	222
8.6.3	\oplus Gradient Boosting Regression Tree	227

8.6.4	⊕ XGBoost	230
9	Model Evaluation and Selection	237
9.1	Model Evaluation	237
9.1.1	Model Evaluation Rules	238
9.1.2	Evaluation Metrics for Classifiers	250
9.1.3	Evaluation Metrics for Regressors	265
9.2	Model Selection	267
9.2.1	Grid Search	268
9.2.2	Random Search	275
10	Feature Selection	283
10.1	Dimensionality Reduction: Feature Selection and Extraction	283
10.2	Feature Selection Techniques	286
10.2.1	Filter Methods	286
10.2.2	Wrapper Methods	293
10.2.3	Embedded Methods	297
11	Assembling Various Learning Steps	303
11.1	Using Cross-Validation Along with Other Steps in a Nutshell	303
11.2	A Common Mistake	305
11.3	Feature Selection and Model Evaluation Using Cross-Validation	307
11.4	Feature and Model Selection Using Cross-Validation	310
11.5	Nested Cross-Validation for Feature and Model Selection, and Evaluation	315
12	Clustering	319
12.1	Partitional Clustering	319
12.1.1	K-Means	321
12.1.2	Estimating the Number of Clusters	328
12.2	Hierarchical Clustering	335
12.2.1	Definition of Pairwise Cluster Dissimilarity	337
12.2.2	Efficiently Updating Dissimilarities	337
12.2.3	Representing the Results of Hierarchical Clustering	340
13	Deep Learning with Keras-TensorFlow	351
13.1	Artificial Neural Network, Deep Learning, and Multilayer Perceptron	351
13.2	Backpropagation, Optimizer, Batch Size, and Epoch	357
13.3	Why Keras?	358
13.4	Google Colaboratory (Colab)	359
13.5	The First Application Using Keras	361
13.5.1	Classification of Handwritten Digits: MNIST Dataset	361
13.5.2	Building Model Structure in Keras	363
13.5.3	Compiling: optimizer, metrics, and loss	366
13.5.4	Fitting	371
13.5.5	Evaluating and Predicting	377

13.5.6	CPU vs. GPU Performance	379
13.5.7	Overfitting and Dropout	379
13.5.8	Hyperparameter Tuning	385
14	Convolutional Neural Networks	393
14.1	CNN, Convolution, and Cross-Correlation	393
14.2	Working Mechanism of 2D Convolution	394
14.2.1	Convolution of a 2D Input Tensor with a 2D Kernel Tensor	395
14.2.2	Convolution of a 3D Input Tensor with a 4D Kernel Tensor	400
14.3	Implementation in Keras: Classification of Handwritten Digits	401
15	Recurrent Neural Networks	415
15.1	Standard RNN and Stacked RNN	415
15.2	\oplus Vanishing and Exploding Gradient Problems	418
15.3	LSTM and GRU	421
15.4	Implementation in Keras: Sentiment Classification	423
	References	435
	Index	445