

**grokking**  
**Machine**  
**Learning**

---

**Luis G. Serrano**

**Foreword by Sebastian Thrun**

  
**MANNING**  
SHELTER ISLAND

For online information and ordering of this and other Manning books, please visit [www.manning.com](http://www.manning.com). The publisher offers discounts on this book when ordered in quantity. For more information, please contact

Special Sales Department  
Manning Publications Co.  
20 Baldwin Road, PO Box 761  
Shelter Island, NY 11964  
Email: [orders@manning.com](mailto:orders@manning.com)

©2021 by Manning Publications Co. All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by means electronic, mechanical, photocopying, or otherwise, without prior written permission of the publisher.

Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in the book, and Manning Publications was aware of a trademark claim, the designations have been printed in initial caps or all caps.

☞ Recognizing the importance of preserving what has been written, it is Manning's policy to have the books we publish printed on acid-free paper, and we exert our best efforts to that end. Recognizing also our responsibility to conserve the resources of our planet, Manning books are printed on paper that is at least 15 percent recycled and processed without the use of elemental chlorine.

The author and publisher have made every effort to ensure that the information in this book was correct at press time. The author and publisher do not assume and hereby disclaim any liability to any party for any loss, damage, or disruption caused by errors or omissions, whether such errors or omissions result from negligence, accident, or any other cause, or from any usage of the information herein.



Manning Publications Co.  
20 Baldwin Road  
Shelter Island, NY 11964

Development editor: Marina Michaels  
Technical development editor: Kris Athi  
Review editor: Aleksander Dragosavljević  
Production editor: Keri Hales  
Copy editor: Pamela Hunt  
Proofreader: Jason Everett  
Technical proofreader: Karsten Strøbæk, Shirley Yap  
Typesetter: Dennis Dalinnik  
Cover designer: Leslie Haimes

ISBN: 9781617295911

Printed in the United States of America

# contents



foreword	ix
preface	xi
acknowledgments	xiii
about this book	xv
about the author	xix
<b>1 What is machine learning? It is common sense, except done by a computer</b>	<b>1</b>
.....	
Do I need a heavy math and coding background to understand machine learning?	2
OK, so what exactly is machine learning?	3
How do we get machines to make decisions with data?	
The remember-formulate-predict framework	6
<b>2 Types of machine learning</b>	<b>15</b>
.....	
What is the difference between labeled and unlabeled data?	17
Supervised learning: The branch of machine learning that works with labeled data	18
Unsupervised learning: The branch of machine learning that works with unlabeled data	22
What is reinforcement learning?	29

<b>3</b>	<b>Drawing a line close to our points: Linear regression</b>	<b>35</b>
	.....	
	The problem: We need to predict the price of a house	37
	The solution: Building a regression model for housing prices	38
	How to get the computer to draw this line: The linear regression algorithm	44
	How do we measure our results? The error function	60
	Real-life application: Using Turi Create to predict housing prices in India	67
	What if the data is not in a line? Polynomial regression	69
	Parameters and hyperparameters	71
	Applications of regression	72
<b>4</b>	<b>Optimizing the training process: Underfitting, overfitting, testing, and regularization</b>	<b>77</b>
	.....	
	An example of underfitting and overfitting using polynomial regression	79
	How do we get the computer to pick the right model? By testing	81
	Where did we break the golden rule, and how do we fix it?	
	The validation set	84
	A numerical way to decide how complex our model should be:	
	The model complexity graph	85
	Another alternative to avoiding overfitting: Regularization	86
	Polynomial regression, testing, and regularization with Turi Create	95
<b>5</b>	<b>Using lines to split our points: The perceptron algorithm</b>	<b>103</b>
	.....	
	The problem: We are on an alien planet, and we don't know their language!	106
	How do we determine whether a classifier is good or bad?	
	The error function	121
	How to find a good classifier? The perceptron algorithm	129
	Coding the perceptron algorithm	137
	Applications of the perceptron algorithm	142

<b>6</b>	<b>A continuous approach to splitting points: Logistic classifiers</b>	<b>147</b>
	Logistic classifiers: A continuous version of perceptron classifiers	149
	How to find a good logistic classifier? The logistic regression algorithm	160
	Coding the logistic regression algorithm	166
	Real-life application: Classifying IMDB reviews with Turi Create	171
	Classifying into multiple classes: The softmax function	173
<b>7</b>	<b>How do you measure classification models? Accuracy and its friends</b>	<b>177</b>
	Accuracy: How often is my model correct?	178
	How to fix the accuracy problem? Defining different types of errors and how to measure them	179
	A useful tool to evaluate our model: The receiver operating characteristic (ROC) curve	189
<b>8</b>	<b>Using probability to its maximum: The naive Bayes model</b>	<b>205</b>
	Sick or healthy? A story with Bayes' theorem as the hero	207
	Use case: Spam-detection model	212
	Building a spam-detection model with real data	226
<b>9</b>	<b>Splitting data by asking questions: Decision trees</b>	<b>233</b>
	The problem: We need to recommend apps to users according to what they are likely to download	240
	The solution: Building an app-recommendation system	241
	Beyond questions like yes/no	257
	The graphical boundary of decision trees	261
	Real-life application: Modeling student admissions with Scikit-Learn	264
	Decision trees for regression	268
	Applications	272

<b>10 Combining building blocks to gain more power: Neural networks</b>	<b>277</b>
.....	
Neural networks with an example: A more complicated alien planet	279
Training neural networks	292
Coding neural networks in Keras	299
Neural networks for regression	308
Other architectures for more complex datasets	309
 <b>11 Finding boundaries with style: Support vector machines and the kernel method</b>	 <b>315</b>
.....	
Using a new error function to build better classifiers	318
Coding support vector machines in Scikit-Learn	324
Training SVMs with nonlinear boundaries: The kernel method	326
 <b>12 Combining models to maximize results: Ensemble learning</b>	 <b>351</b>
.....	
With a little help from our friends	352
Bagging: Joining some weak learners randomly to build a strong learner	354
AdaBoost: Joining weak learners in a clever way to build a strong learner	360
Gradient boosting: Using decision trees to build strong learners	370
XGBoost: An extreme way to do gradient boosting	375
Applications of ensemble methods	384
 <b>13 Putting it all in practice: A real-life example of data engineering and machine learning</b>	 <b>387</b>
.....	
The Titanic dataset	388
Cleaning up our dataset: Missing values and how to deal with them	392
Feature engineering: Transforming the features in our dataset before training the models	395
Training our models	400
Tuning the hyperparameters to find the best model: Grid search	405
Using <i>K</i> -fold cross-validation to reuse our data as training and validation	408