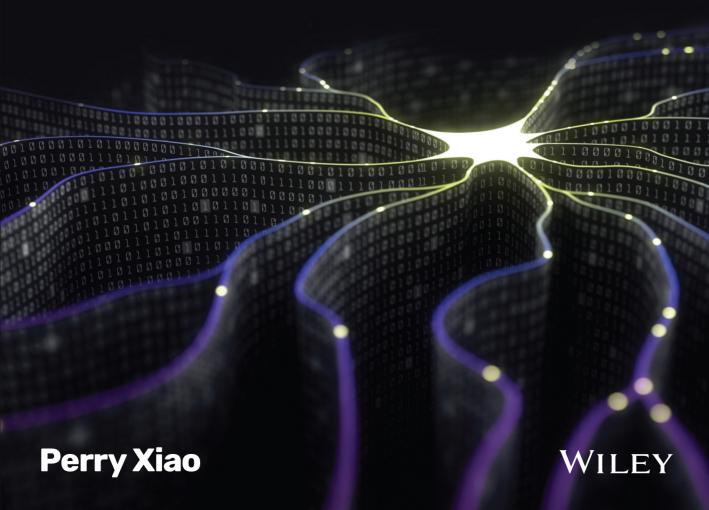
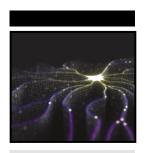
Artificial Intelligence Programming with Python

FROM ZERO TO HERO



Artificial Intelligence Programming with Python®



Artificial Intelligence Programming with Python®

From Zero to Hero

Perry Xiao

WILEY

Copyright © 2022 by John Wiley & Sons, Inc. All rights reserved.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Published simultaneously in Canada.

ISBN: 978-1-119-82086-4 ISBN: 978-1-119-82094-9 (ebk) ISBN: 978-1-119-82096-3 (ebk)

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, scanning, or otherwise, except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without either the prior written permission of the Publisher, or authorization through payment of the appropriate per-copy fee to the Copyright Clearance Center, Inc., 222 Rosewood Drive, Danvers, MA 01923, (978) 750-8400, fax (978) 750-4470, or on the web at www.copyright.com. Requests to the Publisher for permission should be addressed to the Permissions Department, John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, (201) 748-6011, fax (201) 748-6008, or online at http://www.wiley.com/go/permission.

Limit of Liability/Disclaimer of Warranty: The publisher and the author make no representations or warranties with respect to the accuracy or completeness of the contents of this work and specifically disclaim all warranties, including without limitation warranties of fitness for a particular purpose. No warranty may be created or extended by sales or promotional materials. The advice and strategies contained herein may not be suitable for every situation. This work is sold with the understanding that the publisher is not engaged in rendering legal, accounting, or other professional services. If professional assistance is required, the services of a competent professional person should be sought. Neither the publisher nor the author shall be liable for damages arising herefrom. The fact that an organization or Website is referred to in this work as a citation and/or a potential source of further information does not mean that the author or the publisher endorses the information the organization or Website may provide or recommendations it may make. Further, readers should be aware the Internet Websites listed in this work may have changed or disappeared between when this work was written and when it is read.

For general information on our other products and services or for technical support, please contact our Customer Care Department within the United States at (800) 762-2974, outside the United States at (317) 572-3993 or fax (317) 572-4002.

Wiley also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic formats. For more information about Wiley products, visit our web site at www.wiley.com.

Library of Congress Control Number: 2022931189

Trademarks: Wiley and the Wiley logo are trademarks or registered trademarks of John Wiley & Sons, Inc. and/or its affiliates, in the United States and other countries, and may not be used without written permission. Python is a registered trademark of Python Software Foundation. All other trademarks are the property of their respective owners. John Wiley & Sons, Inc. is not associated with any product or vendor mentioned in this book.

Cover image: © ktsdesign/Adobe Stock Photos

Cover design: Wiley

This book is dedicated to my family. To my wife, May, my son, Zieger, and my daughter, Jessica, who make my life complete—without them, life would be meaningless. To my parents and my brother, who have shared their life and love with me that ultimately made me who I am today. To my friends and colleagues, who supported me throughout my career.

I would also like to dedicate this book to Grace Qing Wang, who sadly passed away during the course of writing this book. Grace Qing Wang was a young, energetic professional woman who was passionate about innovation and artificial intelligence in education. She was also a collaborator and a good friend. Through Grace I have made many professional connections that were very beneficial to my career.

About the Author

Dr. Perry Xiao is a professor and course director at the School of Engineering, London South Bank University in London, United Kingdom. He got his BEng degree in opto-electronics, MSc degree in solid-state physics, and PhD degree in photophysics. He is a charted engineering (CEng), a Fellow (FIET) from the Institution of Engineering and Technology (IET), and a Senior Fellow (SFHEA) from the Higher Education Academy (HEA). He has been teaching electronics, software, computer networks, and telecommunication subjects at both the undergraduate level and the postgraduate level for nearly two decades. He also supervises BEng final project students and MSc project students every year. His main research interest is to develop novel infrared and electronic sensing technologies for skin bioengineering applications and industrial nondestructive testing (NDT). To date, he has finished more than 12 PhD student supervisions, obtained two UK patent applications, published more than 100 scientific papers, been editorial reviewer for nine journals, and generated nearly £1 million in research grants.

He is also a director and cofounder of Biox Systems Ltd., UK, a university spin-off company that designs and manufactures state-of-the-art skin measurement instruments, AquaFlux and Epsilon, which have been used in more than 200 organizations worldwide, including leading cosmetic companies, universities, research institutes, and hospitals.

About the Technical Editors

Dr. Hongmei (Mary) He (FHEA, SIEEE) is an associate professor of cybersecurity in the School of Computer Science and Informatics at De Montfort University. Previously, she was a lecturer in AI and cyber security at Cranfield University. She received her PhD in computer science from Loughborough University in the UK in 2006 and gained sustained experience as a postdoctoral researcher at various universities. She has worked as an academic in the field of computer science and engineering for many years and has brief industrial experience at Motorola Design House in China as a senior embedded system engineer. Her research can be briefly divided into four themes: AI and data science, cognitive cybersecurity, cognitive robotics and trustworthy autonomous systems, and computing theory and optimization. Dr. He is a senior member of IEEE in the Computational Intelligence, Cybersecurity, RAS, and Women in Engineering Societies.

Dr. Weiheng Liao, DPhil (Oxon), is a computer scientist and technology entrepreneur in AI. He has authored and co-authored a number of influential papers in top journals and conferences and is the visiting scholar of several research universities. His interests include machine learning, AutoML, deep learning, explainable AI, natural language processing, and their applications in finance and investment. He cofounded YouShore, one of the world's first teams to employ deep NLP to analyze social media data, to extract alternative data, and to construct alpha signals.

If you want to know more about his recent work, please visit www .madebydata.com.

Acknowledgments

I would like to express my sincere gratitude to Wiley Publishing for giving me this opportunity. I would also like to thank Devon Lewis, Liz Britten, Pete Gaughan, Dr. Weiheng Liao, and Hongmei He for their support. Without them, this book would not have been possible.

Contents at a Glance

Pretace		XXIII
Part I	Introduction	
Chapter 1	Introduction to AI	3
Chapter 2	Al Development Tools	23
Part II	Machine Learning and Deep Learning	
Chapter 3	Machine Learning	53
Chapter 4	Deep Learning	117
Part III	Al Applications	
Chapter 5	Image Classification	201
Chapter 6	Face Detection and Face Recognition	265
Chapter 7	Object Detections and Image Segmentations	337
Chapter 8	Pose Detection	433
Chapter 9	GAN and Neural-Style Transfer	465
Chapter 10	Natural Language Processing	491
Chapter 11	Data Analysis	543
Chapter 12	Advanced AI Computing	613
Index		659

This book is accompanied by bonus content! The following extra elements can be downloaded from www.wiley.com/go/aiwithpython:

- MATLAB for AI Cheat Sheets
- Python for AI Cheat Sheets
- Python Deep Learning Cheat Sheet
- Python Virtual Environment
- Jupyter Notebook, Google Colab, and Kaggle

Contents

Preface		xxiii
Part I	Introduction	
Chapter 1	Introduction to AI	3
	1.1 What Is AI?	3
	1.2 The History of AI	5
	1.3 AI Hypes and AI Winters	9
	1.4 The Types of AI	11
	1.5 Edge AI and Cloud AI	12
	1.6 Key Moments of AI	14
	1.7 The State of AI	17
	1.8 AI Resources	19
	1.9 Summary	21
	1.10 Chapter Review Questions	22
Chapter 2	Al Development Tools	23
	2.1 AI Hardware Tools	23
	2.2 AI Software Tools	24
	2.3 Introduction to Python	27
	2.4 Python Development Environments	30
	2.4 Getting Started with Python	34
	2.5 AI Datasets	45
	2.6 Python AI Frameworks	47
	2.7 Summary	49
	2.8 Chapter Review Questions	50
Part II	Machine Learning and Deep Learning	
Chapter 3	Machine Learning	53
-	3.1 Introduction	53
	3.2 Supervised Learning: Classifications	55

	Scikit-Learn Datasets	56
	Support Vector Machines	56
	Naive Bayes	67
	Linear Discriminant Analysis	69
	Principal Component Analysis	70
	Decision Tree	73
	Random Forest	76
	K-Nearest Neighbors	77
	Neural Networks	78
	3.3 Supervised Learning: Regressions	80
	3.4 Unsupervised Learning	89
	K-means Clustering	89
	3.5 Semi-supervised Learning	91
	3.6 Reinforcement Learning	93
	Q-Learning	95
	3.7 Ensemble Learning	102
	3.8 AutoML	106
	3.9 PyCaret	109
	3.10 LazyPredict	111
	3.11 Summary	115
	3.12 Chapter Review Questions	116
Chapter 4	Deep Learning	117
	4.1 Introduction	117
	4.2 Artificial Neural Networks	120
	4.3 Convolutional Neural Networks	125
	4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet	
	4.3 Convolutional Neural Networks4.3.1 LeNet, AlexNet, GoogLeNet4.3.2 VGG, ResNet, DenseNet, MobileNet,	125 129
	4.3 Convolutional Neural Networks4.3.1 LeNet, AlexNet, GoogLeNet4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO	125 129 140
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 	125 129 140 152
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 	125 129 140 152 157
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 	125 129 140 152 157 161
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 	125 129 140 152 157 161 163
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 	125 129 140 152 157 161 163 165
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 	125 129 140 152 157 161 163 165 173
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 	125 129 140 152 157 161 163 165 173
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 	125 129 140 152 157 161 163 165 173
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python 	125 129 140 152 157 161 163 165 173 175
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 	125 129 140 152 157 161 163 165 173 175 176
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 	125 129 140 152 157 161 163 165 173 175 176
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 4.5.1 BERT and ALBERT 	125 129 140 152 157 161 163 165 173 175 176
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 4.5.1 BERT and ALBERT 4.5.2 GPT-3 	125 129 140 152 157 161 163 165 173 175 176
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 4.5.1 BERT and ALBERT 4.5.2 GPT-3 4.5.3 Switch Transformers 	125 129 140 152 157 161 163 165 173 175 176 183 187 187 189 190
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 4.5.1 BERT and ALBERT 4.5.2 GPT-3 4.5.3 Switch Transformers 4.6 Graph Neural Networks 	125 129 140 152 157 161 163 165 173 175 176 183 187 189 190 191
	 4.3 Convolutional Neural Networks 4.3.1 LeNet, AlexNet, GoogLeNet 4.3.2 VGG, ResNet, DenseNet, MobileNet, EffecientNet, and YOLO 4.3.3 U-Net 4.3.4 AutoEncoder 4.3.5 Siamese Neural Networks 4.3.6 Capsule Networks 4.3.7 CNN Layers Visualization 4.4 Recurrent Neural Networks 4.4.1 Vanilla RNNs 4.4.2 Long-Short Term Memory 4.4.3 Natural Language Processing and Python Natural Language Toolkit 4.5 Transformers 4.5.1 BERT and ALBERT 4.5.2 GPT-3 4.5.3 Switch Transformers 	125 129 140 152 157 161 163 165 173 175 176 183 187 187 189 190

		Contents	xvii
	4.8 Meta Learning	195	
	4.9 Summary	197	
	4.10 Chapter Review Questions	197	
Part III	Al Applications		
Chapter 5	Image Classification	201	
	5.1 Introduction	201	
	5.2 Classification with Pre-trained Models	203	
	5.3 Classification with Custom Trained Models:		
	Transfer Learning	209	
	5.4 Cancer/Disease Detection	227	
	5.4.1 Skin Cancer Image Classification	227	
	5.4.2 Retinopathy Classification	229	
	5.4.3 Chest X-Ray Classification	230	
	5.4.5 Brain Tumor MRI Image Classification	231	
	5.4.5 RSNA Intracranial Hemorrhage Detection	231	
	5.5 Federated Learning for Image Classification	232	
	5.6 Web-Based Image Classification	233	
	5.6.1 Streamlit Image File Classification	234	
	5.6.2 Streamlit Webcam Image Classification	242	
	5.6.3 Streamlit from GitHub	248	
	5.6.4 Streamlit Deployment	249	
	5.7 Image Processing	250	
	5.7.1 Image Stitching	250	
	5.7.2 Image Inpainting	253	
	5.7.3 Image Coloring	255	
	5.7.4 Image Super Resolution	256	
	5.7.5 Gabor Filter	257	
	5.8 Summary	262	
	5.9 Chapter Review Questions	263	
Chapter 6	Face Detection and Face Recognition	265	
	6.1 Introduction	265	
	6.2 Face Detection and Face Landmarks	266	
	6.3 Face Recognition	279	
	6.3.1 Face Recognition with Face_Recognition	279	
	6.3.2 Face Recognition with OpenCV	285	
	6.3.3 GUI-Based Face Recognition System	288	
	Other GUI Development Libraries	300	
	6.3.4 Google FaceNet	301	
	6.4 Age, Gender, and Emotion Detection	301	
	6.4.1 DeepFace	302	
	6.4.2 TCS-HumAIn-2019	305	
	6.5 Face Swap	309	
	6.5.1 Face_Recognition and OpenCV	310	
	6.5.2 Simple_Faceswap	315	
	6.5.3 DeepFaceLab	322	

	6.6 Face Detection Web Apps	322
	6.7 How to Defeat Face Recognition	334
	6.8 Summary	335
	6.9 Chapter Review Questions	336
Chapter 7	Object Detections and Image Segmentations	337
	7.1 Introduction	337
	R-CNN Family	338
	YOLO	339
	SSD	340
	7.2 Object Detections with Pretrained Models	341
	7.2.1 Object Detection with OpenCV	341
	7.2.2 Object Detection with YOLO	346
	7.2.3 Object Detection with OpenCV and Deep Learning	351
	7.2.4 Object Detection with TensorFlow, ImageAI, Mask RNN,	
	PixelLib, Gluon	354
	TensorFlow Object Detection	354
	ImageAI Object Detection	355
	MaskRCNN Object Detection	357
	Gluon Object Detection	363
	7.2.5 Object Detection with Colab OpenCV	364
	7.3 Object Detections with Custom Trained Models	369
	7.3.1 OpenCV	369
	Step 1	369 369
	Step 2	
	Step 3	369 370
	Step 4 Step 5	371
	7.3.2 YOLO	372
	Step 1	372
	Step 2	372
	Step 3	373
	Step 4	375
	Step 5	375
	7.3.3 TensorFlow, Gluon, and ImageAI	376
	TensorFlow	376
	Gluon	376
	ImageAI	376
	7.4 Object Tracking	377
	7.4.1 Object Size and Distance Detection	377
	7.4.2 Object Tracking with OpenCV	382
	Single Object Tracking with OpenCV	382
	Multiple Object Tracking with OpenCV	384
	7.4.2 Object Tracking with YOLOv4 and DeepSORT	386
	7.4.3 Object Tracking with Gluon	389

	7.5 Image Segmentation	389
	7.5.1 Image Semantic Segmentation and Image Instance	
	Segmentation	390
	PexelLib	390
	Detectron2	394
	Gluon CV	394
	7.5.2 K-means Clustering Image Segmentation	394
	7.5.3 Watershed Image Segmentation	396
	7.6 Background Removal	405
	7.6.1 Background Removal with OpenCV	405
	7.6.2 Background Removal with PaddlePaddle	423
	7.6.3 Background Removal with PixelLib	425
	7.7 Depth Estimation	426
	7.7.1 Depth Estimation from a Single Image	426
	7.7.2 Depth Estimation from Stereo Images	428
	7.8 Augmented Reality	430
	7.9 Summary	431
	7.10 Chapter Review Questions	431
Chapter 8	Pose Detection	433
	8.1 Introduction	433
	8.2 Hand Gesture Detection	434
	8.2.1 OpenCV	434
	8.2.2 TensorFlow.js	452
	8.3 Sign Language Detection	453
	8.4 Body Pose Detection	454
	8.4.1 OpenPose	454
	8.4.2 OpenCV	455
	8.4.3 Gluon	455
	8.4.4 PoseNet	456
	8.4.5 ML5JS	457
	8.4.6 MediaPipe	459
	8.5 Human Activity Recognition	461
	ActionAI	461
	Gluon Action Detection	461
	Accelerometer Data HAR	461
	8.6 Summary	464
	8.7 Chapter Review Questions	464
Chapter 9	GAN and Neural-Style Transfer	465
	9.1 Introduction	465
	9.2 Generative Adversarial Network	466
	9.2.1 CycleGAN	467
	9.2.2 StyleGAN	469
	9.2.3 Pix2Pix	474
	9.2.4 PULSE	475 475
	9.2.5 Image Super-Resolution	475 478
	7.4.0 41710.017	4/()

	9.3 Neural-Style Transfer	479
	9.4 Adversarial Machine Learning	484
	9.5 Music Generation	486
	9.6 Summary	489
	9.7 Chapter Review Questions	489
Chapter 10	Natural Language Processing	491
	10.1 Introduction	491
	10.1.1 Natural Language Toolkit	492
	10.1.2 spaCy	493
	10.1.3 Gensim	493
	10.1.4 TextBlob	494
	10.2 Text Summarization	494
	10.3 Text Sentiment Analysis	508
	10.4 Text/Poem Generation	510
	10.5.1 Text to Speech	515
	10.5.2 Speech to Text	517
	10.6 Machine Translation	522
	10.7 Optical Character Recognition	523
	10.8 QR Code	524
	10.9 PDF and DOCX Files	527
	10.10 Chatbots and Question Answering	530
	10.10.1 ChatterBot	530
	10.10.2 Transformers	532
	10.10.3 J.A.R.V.I.S.	534
	10.10.4 Chatbot Resources and Examples	540
	10.11 Summary	541
	10.12 Chapter Review Questions	542
Chapter 11	Data Analysis	543
	11.1 Introduction	543
	11.2 Regression	544
	11.2.1 Linear Regression	545
	11.2.2 Support Vector Regression	547
	11.2.3 Partial Least Squares Regression	554
	11.3 Time-Series Analysis	563
	11.3.1 Stock Price Data	563
	11.3.2 Stock Price Prediction	565
	Streamlit Stock Price Web App	569
	11.3.4 Seasonal Trend Analysis	573
	11.3.5 Sound Analysis	576
	11.4 Predictive Maintenance Analysis	580
	11.5 Anomaly Detection and Fraud Detection	584
	11.5.1 Numenta Anomaly Detection	584 584
	11.5.2 Textile Defect Detection	584
	11.5.3 Healthcare Fraud Detection	584
	11.5.4 Santander Customer Transaction Prediction	584

		Contents	xxi
	11.6 COVID-19 Data Visualization and Analysis	585	
	11.7 KerasClassifier and KerasRegressor	588	
	11.7.1 KerasClassifier	589	
	11.7.2 KerasRegressor	593	
	11.8 SQL and NoSQL Databases	599	
	11.9 Immutable Database	608	
	11.9.1 Immudb	608	
	11.9.2 Amazon Quantum Ledger Database	609	
	11.10 Summary	610	
	11.11 Chapter Review Questions	610	
Chapter 12	Advanced Al Computing	613	
	12.1 Introduction	613	
	12.2 AI with Graphics Processing Unit	614	
	12.3 AI with Tensor Processing Unit	618	
	12.4 AI with Intelligence Processing Unit	621	
	12.5 AI with Cloud Computing	622	
	12.5.1 Amazon AWS	623	
	12.5.2 Microsoft Azure	624	
	12.5.3 Google Cloud Platform	625	
	12.5.4 Comparison of AWS, Azure, and GCP	625	
	12.6 Web-Based AI	629	
	12.6.1 Django	629	
	12.6.2 Flask	629	
	12.6.3 Streamlit	634	
	12.6.4 Other Libraries	634	
	12.7 Packaging the Code	635	
	Pyinstaller	635	
	Nbconvert	635	
	Py2Exe	636	
	Py2app	636	
	Auto-Py-To-Exe	636	
	cx_Freeze	637	
	Cython	638	
	Kubernetes	639	
	Docker	642	
	PIP	647	
	12.8 AI with Edge Computing	647	
	12.8.1 Google Coral	647	
	12.8.2 TinyML	648	
	12.8.3 Raspberry Pi	649	
	12.9 Create a Mobile AI App	651	
	12.10 Quantum AI	653	
	12.11 Summary	657	
	12.12 Chapter Review Questions	657	
Index		659	

This book is accompanied by bonus content! The following extra elements can be downloaded from www.wiley.com/go/aiwithpython:

- MATLAB for AI Cheat Sheets
- Python for AI Cheat Sheets
- Python Deep Learning Cheat Sheet
- Python Virtual Environment
- Jupyter Notebook, Google Colab, and Kaggle