

Understanding Artificial Intelligence

Fundamentals and Applications

Albert Chun Chen Liu • Oscar Ming Kin Law • Iain Law


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

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Library of Congress Cataloging-in-Publication Data

Names: Liu, Albert Chun Chen, author. | Law, Oscar Ming Kin, author. | Law, Iain, author.

Title: Understanding artificial intelligence : fundamentals and applications / Albert Chun Chen Liu, Oscar Ming Kin Law, Iain Law.

Description: Hoboken, New Jersey : Wiley-IEEE Press, [2022] | Includes bibliographical references and index.

Identifiers: LCCN 2022017564 (print) | LCCN 2022017565 (ebook) | ISBN 9781119858331 (cloth) | ISBN 9781119858348 (adobe pdf) | ISBN 9781119858386 (epub)

Subjects: LCSH: Artificial intelligence.

Classification: LCC Q335 .L495 2022 (print) | LCC Q335 (ebook) | DDC 006.3–dc23/eng20220718

LC record available at <https://lcn.loc.gov/2022017564>

LC ebook record available at <https://lcn.loc.gov/2022017565>

Cover Design: Wiley

Cover Image: © Blue Planet Studio/Shutterstock

Set in 9.5/12.5pt STIXTwoText by Straive, Pondicherry, India

Printed in the United States of America

*Education is not the learning of facts,
but the training of the mind to think*

Albert Einstein

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Preface

This book is inspired by the Chinese Christian Herald Crusades (Los Angeles), Youth Enrichment and Leadership Program (YELP) – “AI Workshops.” It introduces the youth to the fourth industrial revolution (Industrial Revolution 4.0) – artificial intelligence (AI) technology. The industrial revolution started with the steam engine (1784), electricity (1870), the computer (1969), to the latest AI technology (2012) – neural network. AI combines the neural network with big data (BD) and the internet of things (IoT), which dramatically changes our everyday life. Today, autonomous vehicles (Tesla), virtual assistants (Google Home), and drone delivery (Amazon Prime Air) are all supported by AI. With AI advances, it displaces million and generates more jobs in the near future. History repeats itself, data entry replaced the typist, but data entry offered more job opportunities at the beginning of the computer era. The book shows the readers how to face AI challenges. It explains basic neural network architecture, machine vision, natural language processing (NLP), autonomous vehicle, and drone technologies. It also covers AI developments, healthcare, finance, retail, manufacturing, agriculture, smart city, and government. Finally, it also describes the different hardware designs targeted for AI applications.

The book is organized as follows:

- Chapter 1 describes the AI history and its impact on our world. It shows how the neural network is derived from the human neuron and highlights the popular neural network architectures, convolutional neural network (CNN), recurrent neural network (RNN), and reinforcement learning (RL). Based on the neural network training mechanism, it classifies the networks into supervised learning, semi-supervised learning, and unsupervised learning. It also discusses two primary neural network operations, training and inference.
- Chapter 2 introduces the classical CNN architecture. It briefly explains the primary functional layers, convolutional layer, activation layer, pooling layer, batch normalization, dropout, and fully connected layer.

- Chapter 3 describes the machine vision approach. It focuses on object recognition, especially facial recognition. It explains how to recognize the object through deep convolution neural network (DCNN) and evolve the small feature maps into complete object images. It covers the major machine vision applications in medical diagnosis, retail applications, and airport security.
- Chapter 4 explains how to apply AI for NLP. It focuses on various neural network architectures, CNN, RNN with long-short term memory (LSTM), recursive neural network, and RL. It describes the NLP applications, virtual assistants, language translation, and text transcription.
- Chapter 5 introduces the autonomous vehicle, also called the self-driving car. It lists the autonomous vehicle standard based on the Society of Automotive Engineers (SAE) International. It describes various autonomous technologies, computer vision, sensor fusion, localization, path finding, drive control, communication strategies, vehicle-to-vehicle, vehicle-to-infrastructure, and vehicle-to-pedestrian. It also discusses the autonomous vehicle law legislation and future challenges.
- Chapter 6 introduces the unmanned aerial vehicle (UAV) – drone development. It explores drone designs, applications, and challenges. It lists out both recreational and commercial rules initialized by Federal Aviation Administration (FAA). Finally, it covers the popular drone applications in civil construction, agriculture, and emergence rescue.
- Chapter 7 describes artificial intelligence's impacts on the healthcare system. It includes telemedicine, medical diagnosis, medical imaging, smart medical devices, electronic health records, medical billing, drug development, clinical trial, medical robotics, and elderly care. It also highlights the challenges of AI in the healthcare system.
- Chapter 8 shows how to integrate AI in finance sectors and explores the impacts on fraud detection, financial forecast, stock trading, financial advisory, accounting, and insurance.
- Chapter 9 highlights important changes in future retail, such as e-commerce, virtual shopping, promotion optimization, store management, warehouse management, and supply chain. It also shows the next-generation retail store, the Amazon Go store.
- Chapter 10 describes the AI impacts on manufacturing. It covers defect detection, quality assurance, generative design, predictive maintenance, environment sustainability, and manufacturing optimization. AI dramatically improves overall productivity.
- Chapter 11 lists the changes in agriculture, crop and soil monitoring, agricultural robot, pest control, and precision farming. It shows how to apply AI to reduce the labor demand and increase productivity in agriculture.

- Chapter 12 shows smart city development. It covers smart transportation, smart parking, waste management, smart grid, and environmental health. Currently, New York and Taipei rank the world's top 10 smart cities.
- Chapter 13 describes how the government faces AI challenges, including information technology, human service, law enforcement, legislation, and ethics. It also covers the public perspective toward AI.
- Chapter 14 shows various AI computational platforms, central processing unit (CPU) – Intel, graphical processing unit (GPU) – Nvidia, tensor processing unit (TPU) – Google, and neural processing unit (NPU) – Kneron.

The book also provides the software laboratories, which lets the reader further understand the AI concept using the neural network model Yolo v3 for object detection. The reader can develop different applications using Kneron NPU. The optional Yolo v5¹ example is introduced to improve the object detection performance.

The laboratories are listed as follows:

- Laboratory 1 shows how to install Python and its libraries with Kneron NPU to perform image/video object detection.
- Laboratory 2 describes how to apply Kneron NPU (hardware accelerator) to speed up object detection.
- Laboratory 3 compares the object detection performance using Kneron NPU with different transfer modes: serial, pipeline, and parallel transfer.
- Laboratory 4 provides optional Yolo v5 examples to enhance object detection performance. However, it required additional Nvidia GPU and Microsoft VC++ support for model compilation.

1 Yolo v5 is released in June 2020.