# COMPUTER VISION AND DEEP LEARNING

## Resource Guide



Dr. Adrian Rosebrock
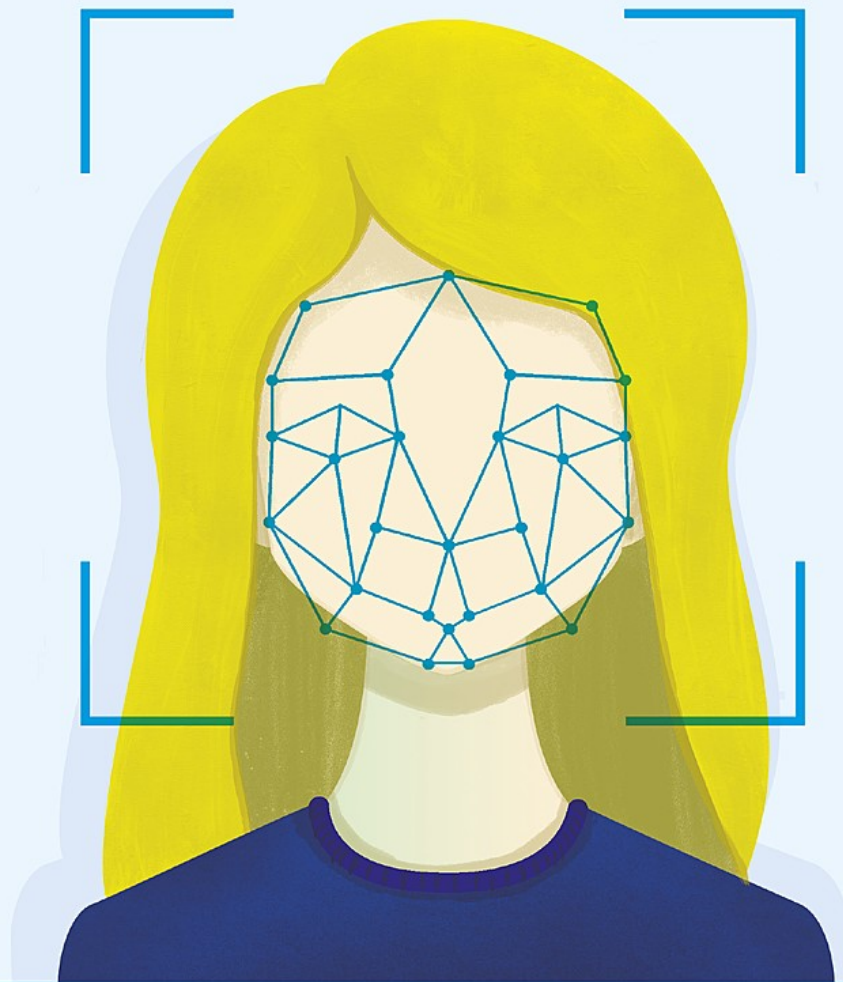
py imagesearch

# Share This Guide

Do you know someone who is interested in computer vision, OpenCV, and deep learning? Please, feel free to share this guide with them. Just send the following link:

http://pyimg.co/guide

# Hello there!

My name is Adrian Rosebrock. I run PyImageSearch.com, a blog dedicated to computer vision, OpenCV, and deep learning. Above all else, my goal is help you on your journey studying computer vision. *Nothing is more important to me.* Enjoy the guide and always feel free to reach out if you have any questions.

*Adrian Rosebrock*
*Chief PyImageSearcher*

**A little more about myself if you're interested:**

I have a Ph.D in computer science with a focus in computer vision and machine learning from the University of Maryland Baltimore County (UMBC).

During my time in college I started two separate computer vision/machine learning startups and consulted with the National Cancer Institute to develop image processing and machine learning algorithms to automatically analyze breast histology images for cancer risk factors.

In the final year of my Ph.D, I started the PyImageSearch blog. Fast forward four years — **PyImageSearch is the largest computer vision and deep learning blog online**.

On PyImageSearch you will find nearly 300 blog posts, tutorials, and guides. I've also authored two books (*Practical Python and OpenCV*; *Deep Learning for Computer Vision with Python*) and a course (PyImageSearch Gurus).

Inside this guide you'll find my curated list of books, conferences, tutorials, blog posts, and Python libraries you should be using to further your computer vision and deep learning education.

I'll also be sure to send you email announcements when I publish new blog posts or tutorials that I think you may like (normally once or twice a week).

Enjoy the guide! And if you found it helpful, please send me an email at adrian@pyimagesearch.com or visit PyImageSearch.com and leave a comment.

I look forward to hearing from you soon!

# Python Libraries and Packages

These are the computer vision and deep learning Python packages that I use *daily*. It is by no means an exhaustive list, but it includes the primary libraries you'll encounter when reading a PyImageSearch blog post.

## OpenCV

Most used computer vision library. Highly efficient. Facilitates real-time image processing.

## imutils

My collection of helper functions and utilities to make working with OpenCV easier.

## dlib

Implementations of state-of-the-art CV and ML algorithms (including face recognition).

## scikit-learn

Machine learning in Python. Simple. Efficient. Beautiful, easy to use API.

## scikit-image

Collection of algorithms for image processing. Contains some algorithm implementations that OpenCV does not.

## TensorFlow

Open source machine learning library. Often used for neural networks, deep learning, and as a computational backend for Keras.

## Keras

High-level neural networks API. Makes coding, training, and deploying neural networks incredibly easy with its scikit-learn style API.

## mxnet

A scalable deep learning framework. *Extremely* fast and efficient. Capable of scaling across multiple GPUs and multiple machines.

# Tutorials, Guides, & Blog Posts

With PyImageSearch nearing 300+ blog posts, tutorials, and guides, I can appreciate how you may feel overwhelmed trying to figure out where to start (and which tutorials are most relevant to you). **To help you get started**, and help you navigate the wealth of content on the PyImageSearch blog, **I've put together the following directory of some of the most popular topics and posts on the blog.** Enjoy and happy reading!

## OpenCV and Image Processing

If you're new to computer vision or OpenCV, or if you're looking to build a cool project using basic concepts, I would suggest starting with these posts.

- How to install OpenCV on your system
- Image Difference with OpenCV and Python
- Rotate images (correctly) with OpenCV and Python
- Bubble sheet multiple choice scanner and test grader using OMR, Python and OpenCV
- Detecting cats in images with OpenCV
- Measuring distance between objects in an image with OpenCV
- Measuring size of objects in an image with OpenCV
- Find distance from camera to object/marker using Python and OpenCV
- OpenCV shape detection
- OpenCV panorama stitching
- Detecting machine-readable zones in passport images
- Pedestrian Detection OpenCV
- Capturing mouse click events with Python and OpenCV
- Multi-scale Template Matching using Python and OpenCV

## Deep Learning

**The intersection of computer vision and deep learning is arguably the most popular subfield of computer science**. It also happens to be one of my favorite topics to write about! Check out these deep learning posts.

- Keras and Convolutional Neural Networks (CNNs)
- How to (quickly) build a deep learning image dataset
- The 7 best deep learning books you should be reading right now
- ImageNet: VGGNet, ResNet, Inception, and Xception with Keras
- Deep Learning with OpenCV
- Object detection with deep learning and OpenCV
- Multi-label classification with Keras
- How-To: Multi-GPU training with Keras, Python, and deep learning
- A fun, hands-on deep learning project for beginners, students, and hobbyists

## Facial Applications

From face detection to face recognition, these applications of computer vision applied to facial applications will keep you busy.

- Face recognition with OpenCV, Python, and deep learning
- Face detection with OpenCV and deep learning
- Facial landmarks with dlib, OpenCV, and Python
- Real-time facial landmark detection with OpenCV, Python, and dlib
- Detect eyes, nose, lips, and jaw with dlib, OpenCV, and Python
- Drowsiness detection with OpenCV
- Eye blink detection with OpenCV, Python, and dlib
- Face Alignment with OpenCV and Python
- (Faster) Facial landmark detector with dlib

## OpenCV and Video

The following tutorials will be helpful to you if you are interested in applying computer vision to real-time video streams and video files.

- Writing to video with OpenCV
- Saving key event video clips with OpenCV
- Real-time panorama and image stitching with OpenCV
- Unifying picamera and cv2.VideoCapture into a single class with OpenCV
- Ball Tracking with OpenCV
- OpenCV Track Object Movement

## Optical Character Recognition (OCR)

OCR is the process of automatically detecting and recognizing text, including characters, letters, and digits, in images. Refer to these tutorials if you're interested in OCR.

- Installing Tesseract for OCR
- Using Tesseract OCR with Python
- Credit card OCR with OpenCV and Python
- Bank check OCR with OpenCV and Python (Part I)
- Bank check OCR with OpenCV and Python (Part II)
- Recognizing digits with OpenCV and Python

## CBIR and Image Search Engines

Content-Based Image Retrieval (CBIR) is the process of building image search engines. Check out these tutorials for more information.

- The complete guide to building an image search engine with Python and OpenCV
- Hobbits and Histograms – A How-To Guide to Building Your First Image Search Engine in Python

# Raspberry Pi

The Raspberry Pi is a versatile piece of hardware, especially when applied to computer vision. I also really enjoy writing tutorials that incorporate the Raspberry Pi. Check out the following Raspberry Pi + computer vision guides.

- Raspberry Pi Face Recognition
- Optimizing OpenCV on the Raspberry Pi
- Real-time object detection with deep learning and OpenCV
- Home surveillance and motion detection with the Raspberry Pi, Python, OpenCV, and Dropbox
- Keras and deep learning on the Raspberry Pi
- Raspberry Pi: Facial landmarks + drowsiness detection with OpenCV and dlib
- Raspberry Pi: Deep learning object detection with OpenCV
- Deep learning on the Raspberry Pi with OpenCV
- Common errors using the Raspberry Pi camera module
- Multiple cameras with the Raspberry Pi and OpenCV

# Interviews

In the past I've interviewed Francois Chollet (the creator of Keras), Davis King (the creator of dlib), PyImageSearch readers, and many others. Take a look at the interviews below.

- An interview with Francois Chollet, creator of Keras and Google AI researcher
- An interview with David Austin: 1st place and $25,000 in Kaggle's most popular image classification competition
- PyImageSearch Gurus member spotlight: Saideep Talari
- An interview with Davis King, creator of the dlib toolkit
- A day in the life of a Adrian Rosebrock: computer vision researcher, developer, and entrepreneur
- PyImageSearch Gurus member spotlight: Tuomo Hiippala

## Meta

Occasionally I write higher level blog posts that are aimed at helping you, the PyImageSearch reader, to get the most value out of the blog. If you find yourself with questions but are unsure how to ask them, these are the guides for you.

- How to get better answers to your computer vision questions
- A guide to asking questions on the PyImageSearch blog

# Books and Courses

In the following sections, you'll find a list of books and courses I recommend to help you study computer vision and deep learning. This list is far from exhaustive, but that is purposeful — there are a *huge* number of books/courses out there and I want to provide you with a curated list to save you time and get you on the path to computer vision + deep learning mastery faster.

## Books I Have Authored

Besides regularly publishing computer vision + deep learning tutorials, articles, and posts on the PyImageSearch blog, I have also authored two books to help you on your computer vision and deep learning journey. Be sure to check them out!
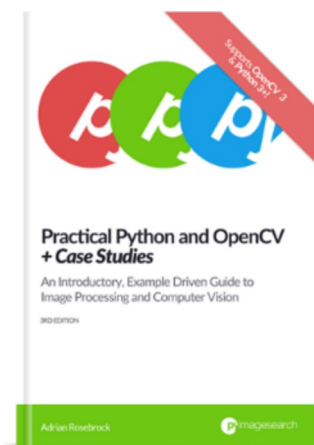
### Practical Python and OpenCV + Case Studies

**Learn computer vision in a single weekend.** Are you interested in computer vision and image processing but don't know where to start? This book is your **guaranteed quick start guide** to learning the fundamentals of computer vision and image processing using Python and OpenCV.

› Click here to learn more.

### Deep Learning for Computer Vision with Python

My new deep learning book has one goal — to **help you become in an expert in deep learning for image recognition and classification**. Inside you'll find *super practical walkthroughs*, *hands-on tutorials*, and a *no-nonsense teaching style* to **help you master deep learning applied to computer vision.**

› Click here to learn more.

# Books and Courses

## Courses I Have Created

If you're looking for a more in-depth treatment of computer vision, make sure you take a look at the **PyImageSearch Gurus course:**
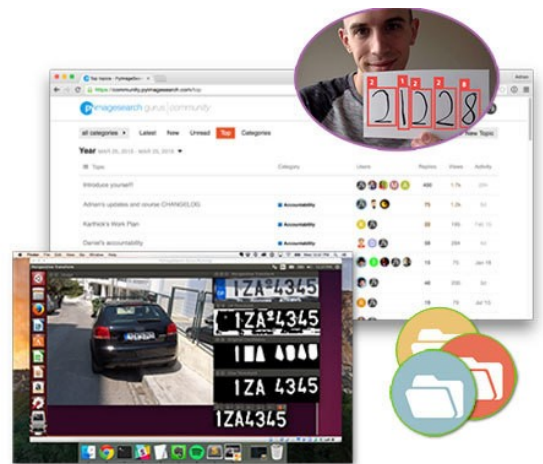


The PyImageSearch Gurus course is **similar to a college-level survey course**, including **13 modules** spanning **168 lessons.** We start off with the fundamentals of computer vision and image processing, and then move on to more advanced concepts, including:

- Face recognition
- Deep learning
- Training your own custom object detectors
- Automatic License/Number Plate Recognition (ANPR)
- Machine learning and image classification
- Hadoop and big data tools for computer vision
- Content-Based Image Retrieval (i.e., image search engines)
- *...and more!*

The PyImageSearch Gurus course is the most in-depth computer vision course available online, so if you're *serious* about studying computer vision, this is *the* course for you.

**TELL ME MORE ABOUT THE COURSE**

# Books and Courses

## Beginner Texts

I recommend these books for someone who is (1) just getting started in the field of computer vision/deep learning and (2) looking for a more code-based text rather than a theory-based one.

- *Learning OpenCV 3 Computer Vision* – Joe Minichino and Joe Howse
- *OpenCV with Python Blueprints* – Michael Beyeler
- *Learning OpenCV* – Gary Bradaski and Adrian Kaehler
- *Programming Computer Vision with Python* – Jan Erik Solem
- *Deep Learning with Python* – Francois Chollet
- *Python Machine Learning: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow* – Sebastian Raschka and Vahid Mirjalili
- *Deep Learning: A Practitioner's Approach* – Josh Patterson and Adam Gibson

## Textbooks

If you are looking for an academic, theory-based book to help you study computer vision and/or deep learning, I recommend the following textbooks:

- *Computer Vision: Algorithms and Applications* – Richard Szeliski
- *Computer Vision: A Modern Approach (2nd edition)* – David A. Forsyth and Jean Ponce
- *Computer Vision* – Linda Shaprio and George Stockman
- *Computer Vision: Models, Learning, and Inference* – Simon Prince
- *Deep Learning* – Ian Goodfellow, Yoshua Bengio, and Aaron Courville
- *Neural Networks and Deep Learning* – Michael Nielsen

# Question:

"Hey Adrian, I am really interested in both the *Deep Learning for Computer Vision with Python* books and your PyImageSearch Gurus course but I'm a bit confused between them. Does the PyImageSearch Gurus course cover everything in the Deep Learning books? **Which one should I go with?**"

*Apoorva Vinod (PyImageSearch reader)*

# Answer:

Hi Apoorva,

Some of the material in the Deep Learning module of the Gurus course also appears in the new *Deep Learning for Computer Vision with Python* books, but the new books have much more breadth and depth than the Gurus module on the topic of Deep Learning itself.

Deep Learning is only *one* module in the PyImageSearch Gurus course. There are dozens of topics beyond deep learning that are covered in the course (such as ANPR, face recognition, and custom object detectors) are not discussed in the new Deep Learning books.

Simply put:

**If your interest is primarily deep learning, you should get the Deep Learning books.**

Otherwise, if you're somewhat interested in deep learning, **but your primary interest is acquiring a broad mastery of computer vision tools and techniques, the Gurus course is what you want.**

Please let me know if you still have questions, I'm happy to help.

*Adrian Rosebrock*
*adrian@pyimagesearch.com*

# There are so many deep learning books — *why this one?*

Don't take it from me. Instead, take a look at the reviews from other PyImageSearch readers who picked up a copy and started their journey to deep learning mastery:

*"I just wanted to let you know that your book is AMAZING! Since the purchase (ImageNet Bundle of course) I've been waking up at 5am to gather the time to consult it before work! The book is written wonderfully and is crystal clear. I finally see a bridge between theory and practice!"*
**Francesco Deso, Software Engineer**

*"Before I started studying your books, I read a lot of books from Packt, some were good, others were not, but yours are far better."*
**Carlo Lisi, Senior Analytics Specialist**

*"Today I passed my PhD candidacy exam and I have a big thanks to convey to you for that. I used your book on computer vision and deep learning and the concepts really helped me implement my solution faster."*
**Harsh Singh, a PhD student**

Join them, and 1000s of other PyImageSearch readers, in computer vision + deep learning mastery.

### Click Here To Pick Up Your Copy!

# Conferences

If you have prior experience in computer vision and deep learning you may want to consider submitting your original research papers to the following top conferences and journals.

## CVPR - Computer Vision and Pattern Recognition

Highly regarded as the top conference in computer vision. Publishing a paper in this conference would put you in the league of world-class research. Under 30% acceptance rate for papers and under 5% for oral presentations.

## ICCV - International Conference on Computer Vision

Considered to be one of the top CV conferences. Extremely competitive and highly regarded. Landing a publication in either CVPR or ICCV is a *huge* deal.

## ECCV - European Conference on Computer Vision

Biennial (once every other year) CV conference. Held on years that ICCV is not. Under 25% poster acceptance rate and under 4% for oral presentations.

## BMVC - British Machine Vision Conference

Smaller conference than CVPR and ICCV, and therefore less accepted papers/talks. Always hosted in the UK.

## NIPS - Conference on Neural Information Processing Systems

Arguably the most illustrious AI conference (and the largest one). Publishing a paper in NIPS undoubtedly reflects world-class research.

# Connect

Want to connect with me on social media? Look no further. Be sure to follow me on Twitter and invite me to your LinkedIn network – these two are my favorite social media sites and I often post exclusive content and behind the scenes looks that are never shown on the PyImageSearch blog.

**Website:** https://www.pyimagesearch.com/

**Email:** adrian@pyimagesearch.com

**Twitter:** @PyImageSearch

**Linkedin:** Adrian Rosebrock

**Google+:** +Adrian Rosebrock

# The most hands-on Deep Learning mastery program you'll find to teach you the skills you absolutely need if you want to succeed in this field.

Whether this is the **first time you've worked with machine learning and neural networks** or **you're already a seasoned deep learning practitioner**, my new book, *Deep Learning for Computer Vision with Python* is engineered from the ground up to help you reach expert status.
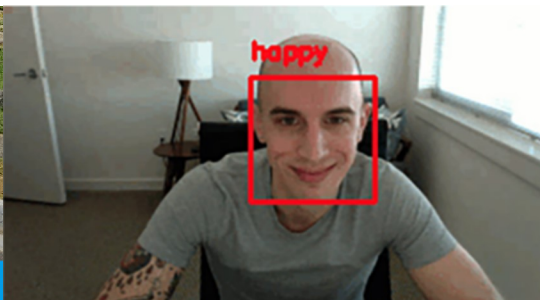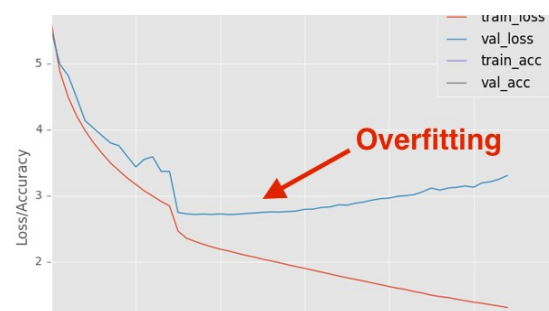


> *"This book is a great, in-depth dive into practical deep learning for computer vision."*
>
> Francois Chollet, Google AI Researcher and creator of Keras

## CLICK HERE TO LEARN MORE!