PACKT PUBLISHING  
MACHINE LEARNING WITH OPENCV JOE MINICHINO



LEVERAGE THE MOST ADVANCED MACHINE LEARNING TECHNIQUES TO BUILD CUTTING EDGE COMPUTER VISION APPLICATIONS

# COURSE DETAILS

## THE COURSE

Work through the bullets below to help you structure and complete this section:

* Machine Learning is a very hot branch of Artificial Intelligence which is being widely adopted by several industries, not only the more obvious technology sector but also manufacturing, medical, security and many more. OpenCV is a state-of-the-art Computer Vision library which allows the creation of cutting edge Computer Vision applications. Machine Learning in a Computer Vision context is rapidly becoming popular and useful for countless purposes, and evolving the accuracy of tasks executed with older and more obsolete techniques. This course will teach how to implement the most popular Machine Learning algorithms with OpenCV.
* While Machine Learning is a hot topic, it also sounds daunting, complicated and very maths-oriented, which tends to scare developers away, but using Machine Learning techniques does not require a full understanding of the maths behind it. Mastering Machine Learning algorithms with OpenCV will vastly improve a developer's profile and skillset, a level beyond the average level of the population of developers.
* The course is divided in four sections: 1. introduction to ML and feature extraction / data preparation, 2. supervised learning, 3. unsupervised learning and 4. a final glance at the upcoming world of deep learning.

## THE AUDIENCE

* This course is ideally aimed at developers with previous experience with Computer Vision and OpenCV, but that never delved into the world of Machine Learning. This course will also be very useful to anybody interested in Machine Learning as the algorithms used in a Computer Vision context are the same as any other context (e.g. Data analysis). Computer Vision / OpenCV developers interested in pushing their applications to the next level will greatly benefit from this course.
* The course requires programming experience, preferably with Python and C++, and some familiarity with OpenCV is preferable but not necessary.
* The course will focus on demonstrating the application of Machine Learning algorithms in a Computer Vision context, performing common (but highly sought-after) tasks such as handwriting recognition, registration plate detection/reading, image recognition and classification, product recognition, object detection etc..

## THE AUTHOR

This section is about you. It helps inform our editorial board of your background and experience, and why you would be a great fit for this project. Don’t worry too much about writing this purely in third person - it’s enough to give us an overview of your expertise.

**What is your current experience with this technology?**

I'm a computer vision developer for the advertising industry, focusing on face detection, age and gender estimation, especially in an Android context.

**What other technologies are you interested in?**

Databases, big data, game development, artificial intelligence

**What other technical skills do you have?**

Having started more than 10 years ago in web development I range from the LAMP (PHP/MySQL) to the more modern MEAN (Node.js, MongoDB, ExpressJS, Angular) passing through years of Java (both EE and with Android), I have numerous JavaScript projects published on Github, I published a book about OpenCV with Python, I like C++ and I am studying Haskell and Clojure, and modern tools such as Apache Storm and Spark.

**Why do you think you would be best suited to develop this video for Packt?**

Because I love the topic and I have vast working experience on it, as well as a book published by Packt on a very similar topic.

**WHAT WILL YOU LEARN**

Users completing this course will learn:

* what Machine Learning is, and how it's used in a Computer Vision context
* the major (most popular and used) supervised and unsupervised Machine Learning algorithms
* how to use the OpenCV's implementation of ML algorithms
* an introduction to deep learning and upcoming ML techniques

# COURSE OUTLINE

Using the top-level brief that you’ve put together, you can start to work some of the finer details. You might see yourself switching back and forth between your brief and your outline as you consolidate your vision for the product, which is absolutely fine.

## INSTALLATION AND SETUP

The course requires that OpenCV be installed with all the extra modules provided by the opencv\_contrib repository, which in turn assumes you have both a C/C++ compiler and Python installed. Nothing else is required for the course.

## VOLUME ONE – Introduction to ML and Feature Extraction/Data Preparation

Two fundamental steps to apply Machine Learning to Computer Vision are the understanding of what Machine Learning is, and the preparation of the data so it can be used by Machine Learning algorithms.

### VOLUME OVERVIEW

Introduction to Machine Learning concepts and data preparation / feature extraction techniques that will allow the use of Machine Learning techniques on existing data.

### SECTION ONE – Introduction to Machine Learning

What is Machine Learning? How are the several ML algorithms divided and what application do they find in Computer Vision?

* Why Machine Learning?
* What are the main categories of Machine Learning algorithms?
* How do you choose a ML algorithm?

### SECTION TWO – Extracting features and preparing the data

In this chapter, we learn about standard data preparation practices and state of art feature extraction techniques with some practical examples. We will cover cv::ml::TrainData class and some of techniques from cv::Feature2D class.

* Understanding training and testing data set preparation
* Choose effective feature extraction technique for given problem

### VOLUME SUMMARY

Each volume needs a short video that describes what you have covered, and what will follow in the next volume (if one exists). This doesn’t have to be too long, and does not need any additional information at the outline stage. It’s enough to just leave this in as a heading.

### VOLUME QUIZ

We include questions and assessments throughout the content within a volume. This is scheduled as part of the project deliverables. You don’t need to explain or modify this heading - just bear in mind that for each volume there will typically be at least a dozen or so multiple choice questions required for each section. We help you write and develop these as standard text, which we convert to interactive quizzes as part of the production process.

## VOLUME TWO – SUPERVISED LEARNING

In this volume we will learn about supervised learning and the ML algorithms available.

### VOLUME OVERVIEW

Supervised learning assumes that a Machine Learning algorithm can be used to train a classification model by using train data that is “labelled”, that is, it's been classified in advance of the training itself.

### SECTION ONE – Normal Bayes Classifier, K-NEAREST NEIGHBORS, LOGISTIC REGRESSION

In this chapter, we learn supervised classification techniques such as normal Bayes classifier, K- nearest neighbor and logistic regression. Through the practical example we cover the core concepts of supervised learning and different classification techniques. We will cover cv::ml::NormalBayesClassifier class here.

* Supervised classification
* Normal Bayes classifier
* Performance evaluation of classifier
* Classification with K-Nearest Neighbors
* Implement hand written digit recognition with KNN
* Logistic Regression
* L1 and L2 regression techniques
* Create a face detection application

### SECTION TWO – Support Vector Machines (SVM)

In this chapter, we will learn about Support Vector Machines. We see how SVM is better than Neural networks with practical example. How to extent SVMs to solve multi-class problems. We will cover cv::ml::SVM class here.

* Effective Use of SVMs
* How to solve multi-class classification problems using SVMs
* To Fine tune free parameter and choose right kernel for given problem
* Create pedestrian detection Application

### SECTION THREE – DECISION TREE, BOOSTING, RANDOM TREES AND ENSEMBLE CLASSIFIERS

In this chapter, we will learn about Decision Trees, Boosting and Random Trees algorithms for classification. How to combine these to build efficient classifier.  We will learn cv::ml::Dtree, cv::ml::Boost and cv::ml::Rtrees class here.

 We will also talk about how to evaluate the performance different machine learning algorithms learn so far. What are the performance parameters? Same problem can be solved with multiple machine learning algorithms but which one is best suitable for given problem; how to choose best model?

* Understand Decision Tree
* Explore the Random Forest Algorithm and boosting
* Ensemble classifiers
* Performance comparison

### VOLUME SUMMARY

Each volume needs a short video that describes what you have covered, and what will follow in the next volume (if one exists).

### VOLUME QUIZ

We include questions and assessments throughout the content within a volume. This is scheduled as part of the project deliverables.

## VOLUME THREE – UNSUPERVISED LEARNING / CLUSTERING

In this chapter, we will cover clustering techniques such as K-Means Clustering, Expectation Maximization. We will learn to solve image segmentation problem using these. We will cover cv::kmeans and  cv::ml::EM class here.

### VOLUME OVERVIEW

In situations where pre-classified data is not available, there are techniques that allow to divided the available data in classes based on clustering techniques, such as K-Means and Expectation Maximization.

### SECTION ONE – K-MEANS

In this chapter, we will cover clustering techniques such as K-Means Clustering, Expectation Maximization. We will learn to solve image segmentation problem using these. We will cover cv::kmeans and  cv::ml::EM class here.

* Understanding clustering techniques
* Explore k-means

Ideally you should aim for between three to five subsections, assuming that each of these will be somewhere between five to ten minutes long.

### SECTION TWO – EXPECTATION MAXIMIZATION

Like with section one, there should be a description here.

* Explore Expectation Maximization
* Create an image segmentation application

### VOLUME SUMMARY

Each volume needs a short video that describes what you have covered, and what will follow in the next volume (if one exists).

### VOLUME QUIZ

We include questions and assessments throughout the content within a volume. This is scheduled as part of the project deliverables.

## VOLUME FOUR – NEURAL NETWORKS AND DEEP LEARNING

In this chapter, we will cover artificial neural networks and take a glance at the world of deep learning.

### VOLUME OVERVIEW

Among the many hot topics in Machine Learning, Deep Learning is probably the hottest. Deep neural networks have their foundation in Artificial Neural Networks (Multilayer Perceptron or MLP), so we will cover Neural Networks first then look into the future with an introduction to Deep Learning.

### SECTION ONE – ARTIFICIAL NEURAL NETWORKS

In this chapter we will cover Neural networks. With the help of practical example, we will learn to effectively train the neural network. We will cover cv::ml::ANN\_MLP class here.

* Understanding neural networks learning algorithms
* Pros and cons of neural network
* Practical tips to effectively train neural network to avoid over-fitting and under-fitting

### SECTION TWO – INTRODUCTION TO DEEP LEARNING

In this chapter we will scratch the surface of the deep learning module of OpenCV, including loading models trained with popular deep learning libraries such as Caffe.

* introduction to the concept of deep learning
* structure of a deep learning network
* convolution
* max pooling