A guided tour to Image Processing and Analysis Using Deep Learning with MATLAB®

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# Introduction

* This document guides you through several tutorials, papers, and resources related to Image Processing and Analysis (with emphasis on deep-learning-based techniques) using MATLAB**.**
* It assumes no prior exposure to Image Processing, Computer Vision, Machine Learning, Deep Learning, or MATLAB.
* It is structured as a step-by-step guide. It is best that you follow it in the intended sequence.

# Required materials

* **Textbook:** 
  + “**Practical Image and Video Processing Using MATLAB**”   
    Oge Marques   
    Wiley/IEEE Press, 2011   
    ISBN-10: 0470048158 | ISBN-13: 978-0470048153

* **Reference book:**
  + “**Image Processing Recipes Using MATLAB**”   
    Oge Marques and Daniel Zysman

(*to appear*)

* **Access to MATLAB** (see details on Part 1)

# Part 1- Accessing MATLAB

You are expected to have frequent access to a computer running MATLAB and some of its toolboxes (notably, the Image Processing, Computer Vision System, and Deep Learning toolboxes) for your assignments and projects.

Several colleges and universities have **a Campus-Wide** **MATLAB license**, which means you can download and install your own personal copy of MATLAB at no cost.   
Follow the instructions at <https://www.mathworks.com/academia/tah-support-program/eligibility.html> to check if your school has a Campus-Wide License.

Otherwise, consider **purchasing your own copy** of the student version of MATLAB.   
For more details, go to: <http://www.mathworks.com/academia/student_version/>

# Part 2- Image processing and computer vision: the big picture

1. Read Chapter 1 of the **textbook**.
2. (OPTIONAL) Watch the TED Talk "How we teach computers to understand pictures", by Professor Fei Fei Li, available at: <https://youtu.be/40riCqvRoMs>

# Part 3- Learning the basics of MATLAB

1. Take the **MATLAB Onramp** training available at <https://www.mathworks.com/learn/tutorials/matlab-onramp.html>
2. Read Chapter 3 of the **textbook** and work on its tutorials / examples / exercises.
3. (OPTIONAL) Watch the 46-min "Introduction to MATLAB" video: [www.mathworks.com/videos/introduction-to-matlab-81592.html](http://www.mathworks.com/videos/introduction-to-matlab-81592.html)   
     
   Don't forget to download the associated source code: <http://www.mathworks.com/matlabcentral/fileexchange/49570-introduction-to-matlab--february-2015->

# Part 4- Learning the basics of image processing in MATLAB

1. Learn more about the MATLAB Image Processing Toolbox and its latest updates (including videos): <https://www.mathworks.com/products/image.html>
2. (OPTIONAL) Watch the 40-min "Introduction to MATLAB with Image Processing Toolbox" video:   
   <https://www.mathworks.com/videos/introduction-to-matlab-with-image-processing-toolbox-90409.html>   
     
   Don't forget to download the associated source code:

<https://www.mathworks.com/matlabcentral/fileexchange/49748-introduction-to-matlab-demo-files>

1. Use the textbook and reference book to learn more about and explore the topics below:

|  |  |
| --- | --- |
| Topic | Suggested reading |
| Image processing fundamentals | Textbook – Chapters 2, 5, and 6, and Appendix A |
| MATLAB and relevant toolboxes | Textbook – Chapters 3 and 4  Reference book – Recipes 1-4 |
| Geometric operations | Textbook – Chapter 7  Reference book – Recipes 5-6 |
| Intensity transformations | Textbook – Chapter 8  Reference book – Recipes 11-14 |
| Summary statistics of images and histogram processing | Textbook – Chapter 9  Reference book – Recipes 7-10 |
| Image filtering and enhancement | Textbook – Chapters 10 and 11  Reference book – Recipes 15-16 |
| Image denoising | Textbook – Chapter 12 |
| Color image processing | Textbook – Chapter 16  Reference book – Recipes 25-28 |
| Image segmentation | Textbook – Chapter 15  Reference book – Recipes 17-19 |
| Global feature detection and extraction | Textbook – Chapter 18  Reference book – Recipes 20, 21, 24, 35-36 |
| Local feature detection, extraction and matching | Reference book – Recipes 37-42 |
| Image classification | Textbook – Chapter 19 |

# Part 5- Learning the basics of Machine Learning in MATLAB

1. Download the "Machine Learning with MATLAB" e-book, available at <https://www.mathworks.com/campaigns/offers/machine-learning-with-matlab.html>
2. Read Section 1 ("Introducing Machine Learning") from the "Machine Learning with MATLAB" to learn about basic ML concepts.
3. Read Section 2 ("Getting Started with Machine Learning") from the "Machine Learning with MATLAB" to learn about the main steps in designing, building, and deploying ML solutions.
4. Read Section 3 ("Applying Unsupervised Learning ") from the "Machine Learning with MATLAB" to learn more about unsupervised learning algorithms such as clustering and principal component analysis (PCA).
5. Read Section 4 ("Applying Supervised Learning ") from the "Machine Learning with MATLAB" to learn about supervised learning algorithms for classification and regression tasks.
6. (OPTIONAL) Watch the 35-min "Machine Learning Made Easy" video: [www.mathworks.com/videos/machine-learning-with-matlab-100694.html](http://www.mathworks.com/videos/machine-learning-with-matlab-100694.html)   
   Don't forget to download the associated source code: <http://www.mathworks.com/matlabcentral/fileexchange/50232-machine-learning-made-easy>
7. Take the **MATLAB Machine Learning Onramp** training available at <https://www.mathworks.com/learn/tutorials/machine-learning-onramp.html>
8. (OPTIONAL) Watch the 41-min "Machine Learning with MATLAB" video: <http://www.mathworks.com/videos/machine-learning-with-matlab-81984.html>

Don't forget to download the associated source code: <http://www.mathworks.com/matlabcentral/fileexchange/42744-machine-learning-with-matlab>

1. Try (in the browser!) the interactive example / "test drive" for the MATLAB Classification Learner app at:   
   <https://www.mathworks.com/campaigns/offers/machine-learning-try-in-browser.html>
2. Read the "Mastering Machine Learning" e-book, available at <https://www.mathworks.com/campaigns/offers/mastering-machine-learning-with-matlab.html>

# Part 6- Learning the basics of Deep Learning in MATLAB

1. Start from <https://www.mathworks.com/solutions/deep-learning.html> for an overview of the available tools and resources for deep learning using MATLAB.
2. (OPTIONAL) Watch the introductory video ("[Top 5 Reasons to Use MATLAB for Deep Learning](https://www.mathworks.com/videos/top-5-reasons-to-use-matlab-for-deep-learning-1569565612133.html)") for a quick overview of the current state of deep learning support in MATLAB.
3. Take the **MATLAB Deep Learning Onramp** training available at <https://www.mathworks.com/learn/tutorials/deep-learning-onramp.html>
4. Round up your understanding of Deep Learning and Machine Learning by reading, watching the videos, and answering the quizzes from the interactive e-book "Deep Learning and Traditional Machine Learning: Choosing the Right Approach", available at: <https://explore.mathworks.com/machine-learning-vs-deep-learning>

# Part 7- Image processing and computer vision using deep learning in MATLAB

1. Start from <https://www.mathworks.com/help/deeplearning/deep-learning-with-images.html> for an overview of the available tools and resources for building deep learning solutions for image processing, image analysis, and computer vision using MATLAB.
2. Try (in the browser!) the MATLAB example for image classification with deep learning at: <https://www.mathworks.com/campaigns/offers/deep-learning-try-in-browser.html>
3. (OPTIONAL) Watch the 27-min "Object Recognition: Deep Learning and Machine Learning for Computer Vision" video (archived webinar): <https://goo.gl/yiakuj>

Don't forget to download the associated source code: <https://goo.gl/d4oeGR>

1. Work on the hands-on assignment "Image denoising using deep learning techniques".
2. Work on the hands-on assignment "Semantic image segmentation using deep learning".
3. Select a topic for your term project.
4. Prepare and submit your term project.

**Additional useful links:**

# Neural Networks and Deep Learning

* "*Deep Learning*" by Ian Goodfellow and Yoshua Bengio and Aaron Courville (an MIT Press book):   
  <http://www.deeplearningbook.org/>
* "*Neural Networks and Deep Learning*" by Michael Nielsen (free online book, examples in Python):   
  <http://neuralnetworksanddeeplearning.com/index.html>
* DeepLearning.TV (YouTube channel): <https://www.youtube.com/channel/UC9OeZkIwhzfv-_Cb7fCikLQ>
* Henry AI Labs (YouTube channel): <https://www.youtube.com/channel/UCHB9VepY6kYvZjj0Bgxnpbw>
* 3Blue1Brown (YouTube channel): <https://www.youtube.com/channel/UCYO_jab_esuFRV4b17AJtAw>

# MATLAB

* MATLAB Image Processing toolbox:   
  <https://www.mathworks.com/products/image.html>
* MathWorks “Steve on Image Processing” blog:   
  <https://blogs.mathworks.com/steve/>
* MATLAB for Deep Learning:   
  <https://www.mathworks.com/solutions/deep-learning.html>
* MathWorks Deep Learning blog:   
  <https://blogs.mathworks.com/deep-learning/>