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Deep Learning Foundation with Applications in Computer Vision

Course Duration (8x1/2 Days)

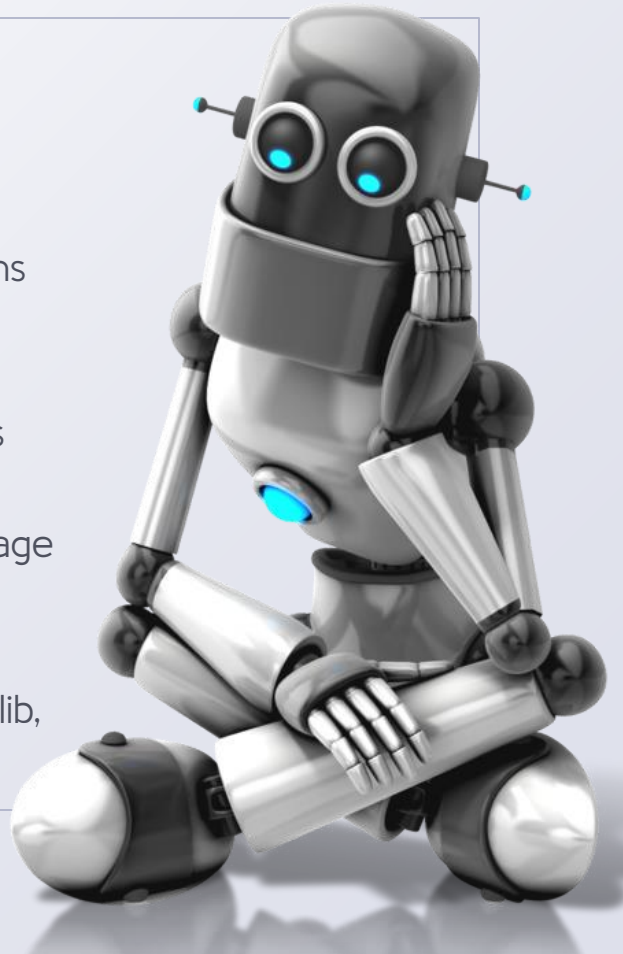
Introduction

In this course, various machine and deep learning algorithms will be explored. Starting from the basics of machine and deep learning, the participants will learn how to construct various machine and deep learning systems from their basic building blocks, and will understand how to apply them to real-world scenarios. Python will be used for all examples and exercises during the hands-on sessions. It is an extremely versatile programming language with clear and intuitive syntax. Most importantly, there is a large collection of Python packages or libraries that expedite the implementation of machine and deep learning systems.

Course Objectives

During this course, you will be able to:

- Explore typical building blocks of machine learning systems
- Realize different machine learning and deep learning techniques
- Discover the architecture of convolution neural networks (CNN)
- Build machine learning and deep learning systems for image classification
- Evaluate learning algorithms
- Use of various Python packages: NumPy, pandas, matplotlib, scikit-learn, TensorFlow, and Keras

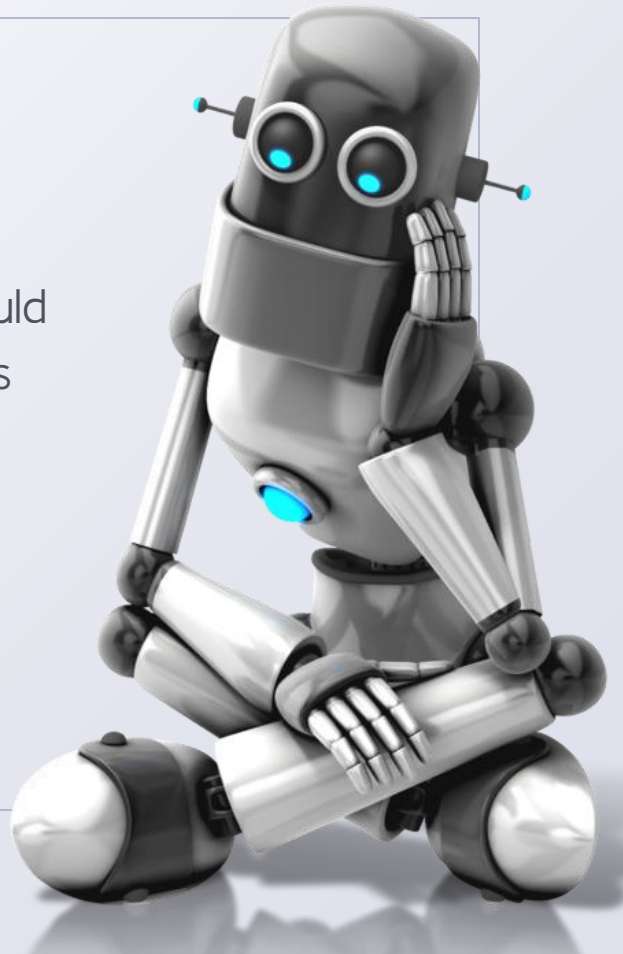


Methodology

The course is presented in Socratic style lectures and workshops with interactive sessions that walk through problem examples that are commonly encountered in real-world situations. The following Python packages will be used throughout this course: NumPy, pandas, matplotlib, scikit-learn, TensorFlow, and Keras. During the hands-on session, the Anaconda distribution of Python 3 will be used for the machine learning as well as basic deep learning examples and exercises. For convolutional neural networks, Google Colaboratory will be used to train the deep learning models and the resulting models will be deployed on a typical computer system.

Who Should Attend

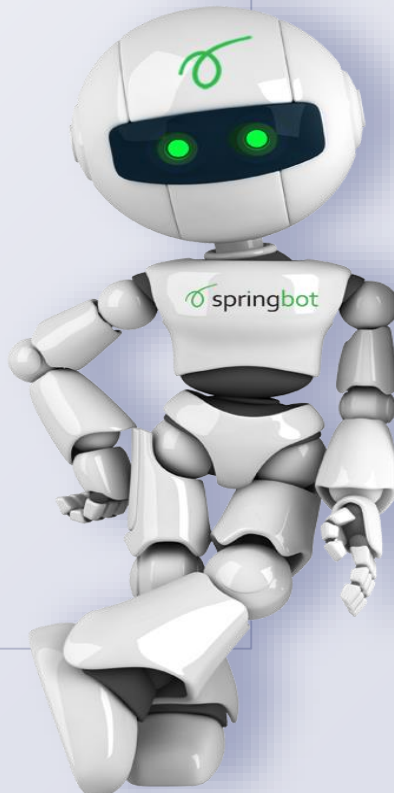
Developers, programmers, and engineers who would like to add an intelligent layer into their applications are encouraged to attend the course.



Course Outline

PART 1

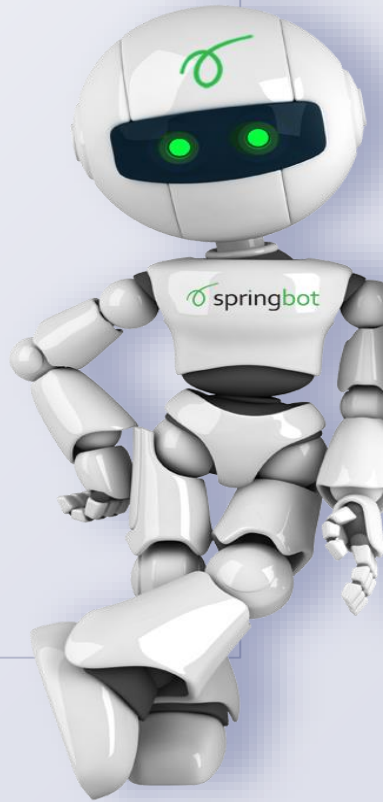
Preparatory Modules (Python, Image Processing)		
Module	Title	Topics/Use Cases
PY1	Python Quickstart & Image Processing Operations	• Key Python Libraries: Numpy, Scipy, Pandas, Matplotlib, OpenCV • Basic Image Processing: Image Transformation & Manipulation • Image Analysis (Morphology, Region Processing) • Image Segmentation
PY2	Feature Extraction in Image Processing	• Low-level Feature Extraction (Points, Corners) • Shape & Texture Features • Higher-level Feature Representations



Course Outline

PART 2

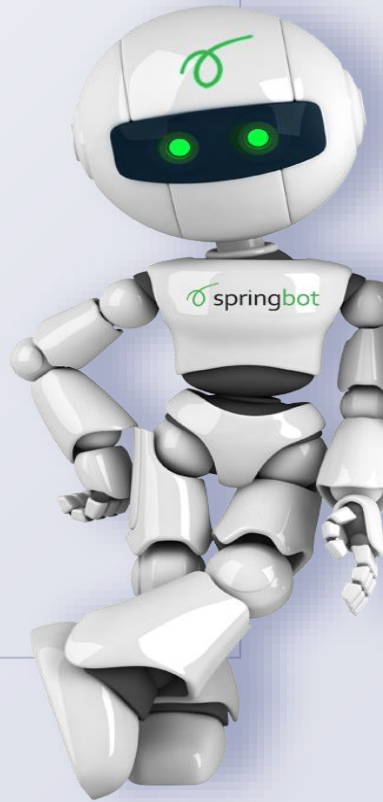
Deep Learning Modules		
Module	Title	Topics/Use Cases
DL1	Introduction to Machine Learning & Deep Learning	• Background and Motivations for Deep Learning • Current Deep Learning Advances • Revisiting Traditional Machine Learning Pipelines • Fundamental Concepts of Neural Networks: Weights, bias, activation functions, back-propagation, gradient optimization
DL2	Convolutional Neural Networks & Object Classification	• Overview on Convolutional Neural Networks (CNN) • Basic concepts – filters, receptive field, stride, padding • Layers – convolutional, pooling, fullyconnected • Setting Up/Using Pre-trained Models • Practical Considerations for Model Selection and Usage • Use Case: Wafer Map Pattern Classification



Course Outline

PART 2

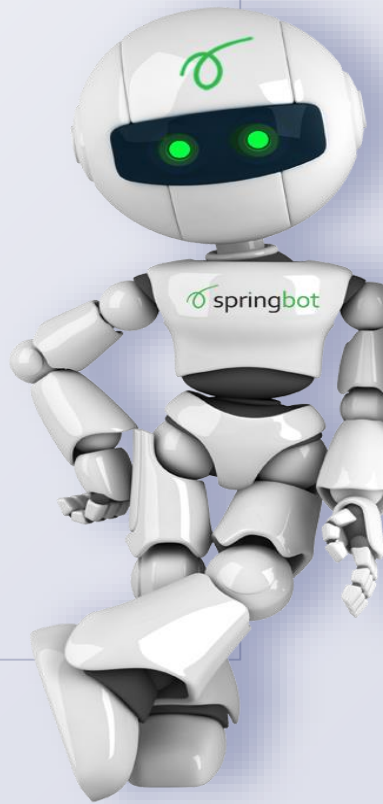
Deep Learning Modules		
Module	Title	Topics/Use Cases
DL3	Data Augmentation & Imbalanced Data Issues	• Types of Transfer Learning Techniques (Bottlenecked Features, Fine-tuning) • Hyper-parameter tuning – batch size, training epochs, decay rate, early stopping • Batch normalization, Regularization (L2/L1/Dropout)
DL4	Convolutional Neural Networks & Object Classification	• Data Pre-processing Techniques • Data Augmentation • Handling Imbalanced Data (Class Resampling, Hard Mining) • Feasible Performance Metrics for Data Imbalance Cases



Course Outline

PART 2

Deep Learning Modules		
Module	Title	Topics/Use Cases
DL5	Object Detection with Deep Learning	• Overview on Object Detection • Selective search & Region proposals • Two-stage detectors: R-CNN and its fast variants • Single stage detectors: YOLO, SSD • Labeling & Annotation • Use Case: Text Detection
DL6	Segmentation with Deep Learning	• Data Pre-processing Techniques • Data Augmentation • Handling Imbalanced Data (Class Resampling, Hard Mining) • Feasible Performance Metrics for Data Imbalance Cases

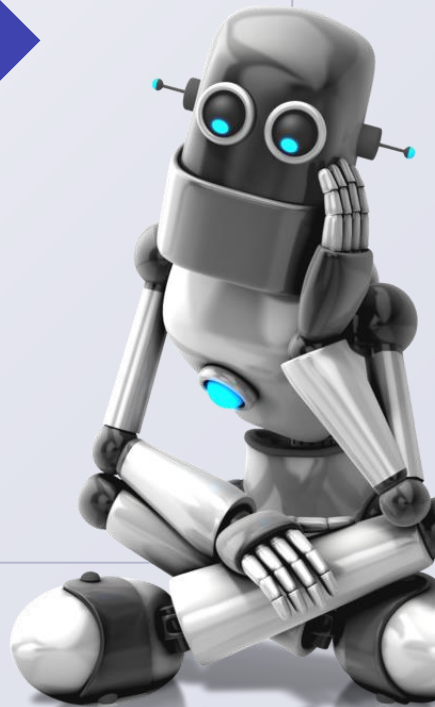


Improving Deep Learning Performance

- Revisiting bias and variance
- Data Optimization
  - o Balancing a dataset
  - o Augmentation
- Hyperparameter tuning in the context of CNN
  - o Learning Rate Decay
  - o Batch size, number of epochs and batch normalization
  - o Early Stopping
  - o Dropout and Regularization
- Ensembles
- Hands-on: Improving performance of defect detection

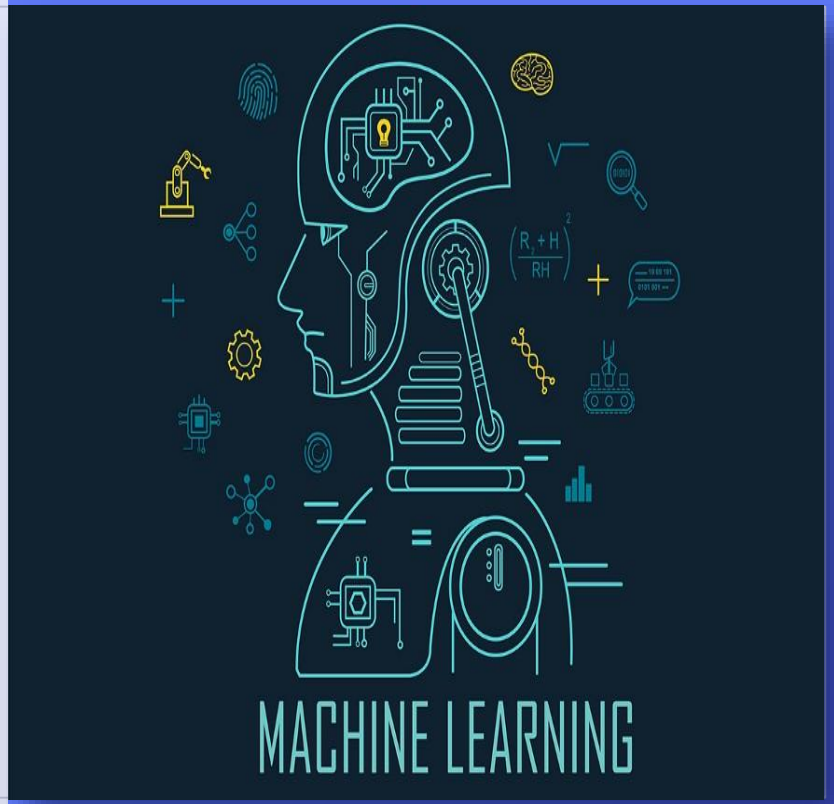
Object Localization and Segmentation

- Overview of localization, segmentation and applications
- Converting a CNN to FCN
- Sliding windows
- Non-maxima suppression
- Single-shot vs region proposal
- Loss function for segmentation
- Unpooling/upsampling/deconvolutions
- State of the art localization frameworks
  - RCNN
  - SSD / YOLO
- State of the art segmentation frameworks
  - SegNet
  - Encoder/decoder: U-NETs
  - Dilated Convolutions
  - Mask-RCNN



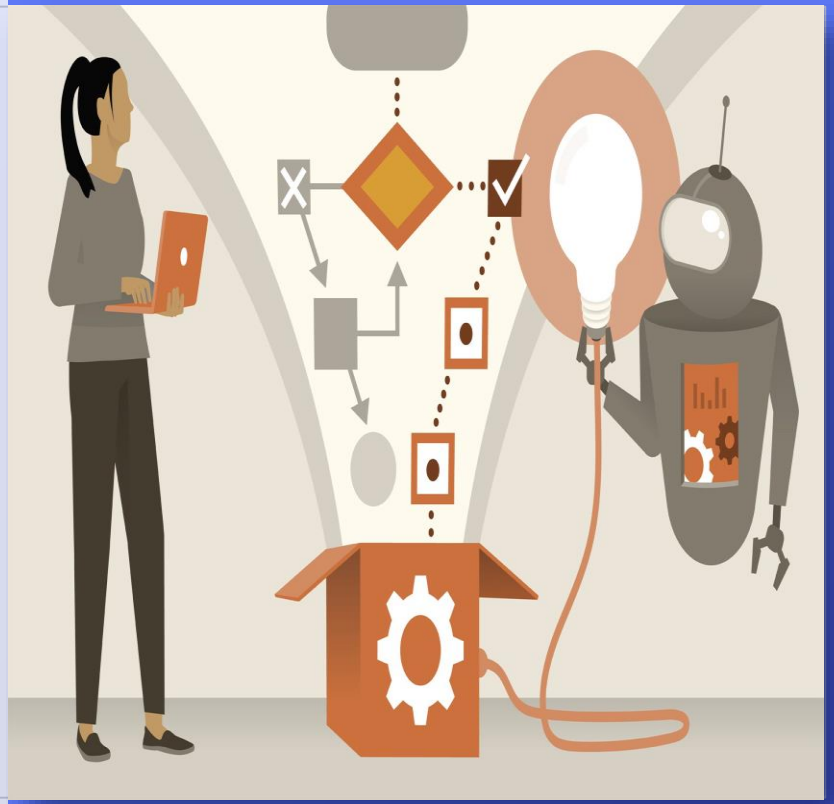
Machine Learning Basics

- Machine Learning Pipeline
- Data preparation
- Learning, Validation and Evaluation
- Bias/variance
- Hyperparameter tuning



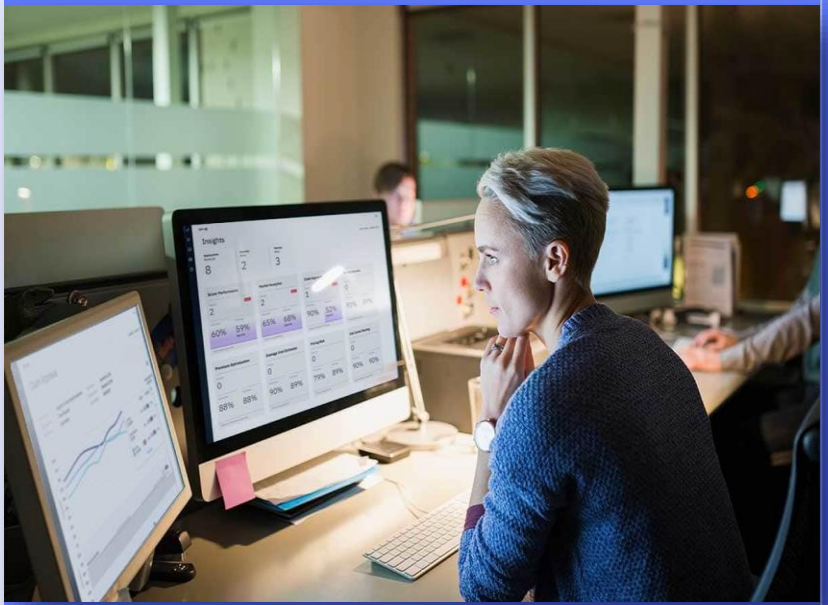
Machine Learning Models

- Overview of supervised vs unsupervised models
- Overview of classification vs regression tasks
- Supervised methods
- Unsupervised methods
- Hands-on: House price prediction, Defect detection



Application and Use Case

- Case #1: Autonomous driving
- Case #2: Defect localization and segmentation
- Other case studies



Note!

- Object Localization and Segmentation are without hands-on training. With hands-on, require an additional day.
- Overview of computer vision techniques is very brief. It only covers image representation and filtering, which are required for understanding of using deep learning for computer vision.

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