Training Course on Deep Learning for Signal and Image Processing

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

This intensive training course provides a comprehensive deep dive into Deep Learning for Signal and Image Processing, equipping participants with the cutting-edge skills to design, develop, and deploy intelligent solutions across various domains. Training Course on Deep Learning for Signal and Image Processing meticulously covers the foundational concepts of neural networks, convolutional neural networks (CNNs), recurrent neural networks (RNNs), and transformers, specifically tailored for applications in audio processing, time-series analysis, medical imaging, computer vision, and communication systems. Attendees will gain hands-on expertise with leading deep learning frameworks such as TensorFlow and PyTorch, mastering crucial techniques like data augmentation, transfer learning, model optimization, and deployment strategies for real-world scenarios. This course is essential for engineers, researchers, and developers seeking to leverage the transformative power of deep learning to extract insights, make predictions, and automate tasks in complex signal and image data.

The program emphasizes practical application and industry best practices, exploring trending topics like generative adversarial networks (GANs) for data synthesis, explainable AI (XAI) for model interpretability, reinforcement learning for signal/image control, and efficient inference on edge devices. Participants will delve into advanced architectures for segmentation, object detection, speech recognition, and natural language processing (NLP) applied to multimodal data. By the end of this course, attendees will possess the expertise to architect and implement sophisticated deep learning models for diverse signal and image processing challenges, driving innovation, automation, and superior performance in fields such as autonomous systems, healthcare, media, and telecommunications. This training empowers professionals to unlock new opportunities and solve complex problems in an increasingly data-intensive world.

Programme Curriculum

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Course Objectives

1. Understand the core principles of Deep Learning and its distinct advantages for signal and image data.
2. Design and implement Convolutional Neural Networks (CNNs) for image classification and recognition.
3. Apply advanced CNN architectures (ResNet, Inception, EfficientNet) for complex image tasks.
4. Utilize Recurrent Neural Networks (RNNs) and LSTMs for time-series analysis and sequence data.
5. Implement Transformers for sequence-to-sequence tasks in signal and natural language processing.
6. Perform image segmentation using U-Net, Mask R-CNN, and other deep learning techniques.
7. Develop object detection models with architectures like YOLO, SSD, and Faster R-CNN.
8. Apply deep learning for audio and speech processing (e.g., speech recognition, emotion detection).
9. Implement Generative Adversarial Networks (GANs) for data augmentation and synthesis.
10. Optimize and deploy deep learning models for efficient inference on various platforms (GPU, edge devices).
11. Understand and apply Transfer Learning techniques to accelerate model development.

12. Explore Explainable AI (XAI) methods to interpret deep learning model decisions in signal/image contexts.
13. Address data augmentation strategies specific to signal and image datasets.

Organizational Benefits

1. Accelerated development of AI-powered products leveraging signal and image data.
2. Improved accuracy and performance in existing image and signal processing applications.
3. Enhanced capabilities in computer vision and audio analysis, leading to new product features.
4. Reduced time-to-market for innovative solutions in areas like autonomous systems, healthcare, and security.
5. Better utilization of large datasets through automated feature extraction and learning.
6. Competitive advantage in industries adopting AI for image and signal intelligence.
7. Increased capacity for in-house R&D in advanced deep learning applications.
8. Optimized resource allocation by automating inspection, monitoring, and analysis tasks.
9. More robust and intelligent systems for anomaly detection and pattern recognition.
10. Upskilling of the workforce in the most in-demand AI technologies.

Target Participants

- Software Engineers
- Data Scientists
- AI/ML Engineers
- Image Processing Engineers
- Signal Processing Engineers
- Researchers in AI/ML

Course Outline

Module 1: Deep Learning Fundamentals Review

- **Neural Network Basics:** Neurons, activation functions, layers, forward propagation.
- **Backpropagation and Gradient Descent:** Training neural networks, optimization algorithms.
- **Overfitting and Regularization:** L1/L2, Dropout, Batch Normalization.
- **Introduction to TensorFlow and PyTorch:** Core concepts and workflow.
- **Case Study:** Building a simple multi-layer perceptron (MLP) for classification on a basic dataset.

Module 2: Introduction to Image Processing with Deep Learning

- **Image Data Representation:** Pixels, channels, tensors.
- **Image Preprocessing for DL:** Resizing, normalization, data augmentation.
- **Convolutional Layers:** Filters, strides, padding, feature extraction.
- **Pooling Layers:** Max Pooling, Average Pooling, downsampling.
- **Case Study:** Training a small CNN to classify handwritten digits (MNIST dataset).

Module 3: Advanced Convolutional Neural Networks (CNNs)

- **Classic Architectures:** LeNet, AlexNet, VGG.

- **Residual Networks (ResNet):** Skip connections for deeper networks.
- **Inception Networks:** Multi-scale feature extraction.
- **EfficientNet and MobileNets:** Efficient architectures for mobile and edge devices.
- **Case Study:** Applying a pre-trained ResNet model for image classification using transfer learning on a custom dataset.

Module 4: Image Classification and Recognition

- **Data Augmentation for Images:** Rotation, scaling, flipping, color jitter.
- **Loss Functions for Classification:** Cross-entropy loss.
- **Transfer Learning Strategies:** Feature extraction, fine-tuning.
- **Evaluating Classification Models:** Accuracy, precision, recall, F1-score, confusion matrix.
- **Case Study:** Building an image classifier for medical images (e.g., detecting pneumonia from X-rays).

Module 5: Object Detection with Deep Learning

- **Introduction to Object Detection:** Bounding boxes, confidence scores.
- **Two-Stage Detectors:** Faster R-CNN (Region Proposal Networks).
- **One-Stage Detectors:** YOLO (You Only Look Once), SSD (Single Shot MultiBox Detector).
- **Evaluation Metrics:** Intersection over Union (IoU), Mean Average Precision (mAP).
- **Case Study:** Implementing an object detection model to identify defects on a manufacturing assembly line.

Module 6: Image Segmentation

- **Semantic Segmentation:** Pixel-level classification (e.g., FCN, U-Net).
- **Instance Segmentation:** Detecting and segmenting individual objects (e.g., Mask R-CNN).
- **Loss Functions for Segmentation:** Dice Loss, Focal Loss.
- **Applications:** Medical image analysis, autonomous driving, background removal.
- **Case Study:** Performing semantic segmentation on satellite imagery to identify land cover types.

Module 7: Recurrent Neural Networks (RNNs) for Signal Processing

- **Sequential Data Challenges:** Handling time dependencies.
- **Basic RNN Architecture:** Recurrence, unrolling, vanishing/exploding gradients.
- **Long Short-Term Memory (LSTM) Networks:** Addressing gradient issues.
- **Gated Recurrent Units (GRUs):** Simplified LSTMs.
- **Case Study:** Forecasting stock prices or sensor readings using an LSTM network.

Module 8: Time-Series Analysis with Deep Learning

- **Time-Series Data Preprocessing:** Windowing, normalization, feature extraction (e.g., statistical features).
- **RNN/LSTM/GRU for Forecasting:** Univariate and multivariate time series.
- **Sequence-to-Sequence Models:** Encoder-decoder architectures for complex sequence mapping.
- **Evaluation Metrics for Time-Series:** MAE, MSE, RMSE, MAPE.
- **Case Study:** Predicting equipment failures based on real-time sensor data using LSTMs.

Module 9: Deep Learning for Audio and Speech Processing

- **Audio Data Representation:** Waveforms, spectrograms, MFCCs.

- **CNNs for Audio:** Applying convolutions to spectrograms.
- **RNNs/LSTMs for Speech:** Sequence modeling for speech recognition.
- **Applications:** Speech-to-text, speaker identification, emotion recognition, sound event detection.
- **Case Study:** Building a simple keyword spotting system using a CNN on audio spectrograms.

Module 10: Transformer Networks for Sequence Processing

- **Attention Mechanism:** Self-attention, multi-head attention.
- **Transformer Architecture:** Encoder-decoder blocks, positional encoding.
- **Transformers for Time-Series:** Applying attention to sequential data.
- **Vision Transformers (ViT):** Applying transformers to image processing.
- **Case Study:** Using a transformer-based model for anomaly detection in long time-series data.

Module 11: Generative Models (GANs and VAEs)

- **Generative Adversarial Networks (GANs):** Generator, Discriminator, adversarial training.
- **Variational Autoencoders (VAEs):** Encoding and decoding latent spaces.
- **Applications:** Image synthesis, data augmentation, anomaly detection (using reconstruction error).
- **Conditional GANs (CGANs):** Generating specific types of data.
- **Case Study:** Generating synthetic medical images to augment limited datasets for training.

Module 12: Model Optimization and Deployment

- **Model Quantization:** Reducing precision for faster inference and smaller models.
- **Model Pruning and Sparsity:** Removing redundant connections.
- **TensorFlow Lite, ONNX Runtime:** Frameworks for inference optimization.
- **Deployment on Edge Devices:** Challenges and strategies for resource-constrained environments.
- **Case Study:** Optimizing an image classification model for deployment on a Raspberry Pi or NVIDIA Jetson.

Module 13: Explainable AI (XAI) for Deep Learning

- **Importance of XAI:** Trust, transparency, debugging.
- **Local Explanations:** LIME, SHAP for understanding individual predictions.
- **Global Explanations:** Class Activation Maps (CAM, Grad-CAM) for CNNs.
- **Counterfactual Explanations:** What-if scenarios.
- **Case Study:** Interpreting the decisions of a deep learning model for medical image diagnosis using Grad-CAM.

Module 14: Deep Learning for Medical Imaging

- **Medical Image Modalities:** X-ray, MRI, CT, Ultrasound.
- **Pre-processing Medical Images:** Noise reduction, bias correction, registration.
- **DL for Diagnosis:** Classification (disease detection).
- **DL for Prognosis and Treatment Planning:** Segmentation (tumor delineation), registration.
- **Case Study:** Developing a deep learning model for detecting abnormalities in MRI scans.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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