Training Course on Advanced Convolutional Neural Networks

Professional Development Training Course Outline

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

Course Introduction

Training Course on Advanced Convolutional Neural Networks (CNNs) empowers professionals with the in-depth knowledge and practical skills to design, implement, and optimize state-of-the-art CNN architectures like ResNet, Inception, and EfficientNet. Participants will gain a deep understanding of advanced deep learning concepts, transfer learning, and efficient model deployment, directly translating into enhanced computer vision capabilities for their organizations.

The curriculum focuses on hands-on application, utilizing leading deep learning frameworks and real-world datasets to tackle complex image and video analysis challenges. From object detection and image classification to medical imaging and autonomous systems, this course provides a robust foundation for leveraging cutting-edge CNNs to drive innovation, improve decision-making, and achieve significant competitive advantages in the rapidly evolving AI landscape.

Programme Curriculum

Training Course on Advanced Convolutional Neural Networks (CNNs)

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Course Objectives

1. Comprehend the foundational principles and intricate designs of ResNet, Inception, and EfficientNet for superior **image recognition** and **computer vision** tasks.
2. Implement advanced **optimization algorithms** and techniques, including **batch normalization** and **regularization**, to enhance CNN training efficiency and generalization.
3. Apply **transfer learning** strategies with pre-trained models for accelerated development and improved performance on novel **image datasets**.
4. Develop robust solutions for **real-time object detection** and localization using advanced CNN backbones like YOLO and SSD.
5. **Understanding Semantic Segmentation:** Explore and implement techniques for **semantic segmentation**, achieving pixel-level classification for detailed image analysis.
6. Gain insights into how CNNs are integrated into **generative models** for synthetic data generation and advanced image manipulation.
7. Master various **data augmentation** strategies to expand training datasets and prevent overfitting in deep CNN models.
8. Optimize CNN models for **edge AI** and resource-constrained environments, ensuring efficient deployment in real-world applications.
9. Critically evaluate CNN performance using key metrics like **accuracy, precision, recall**, and **F1-score** for robust model validation.
10. Gain proficiency in leading **deep learning frameworks** such as TensorFlow and PyTorch for scalable CNN development.
11. Discover the transformative role of advanced CNNs in **medical imaging analysis** and **disease diagnosis**.
12. Understand the critical application of CNNs in **autonomous vehicles** for environmental perception and navigation.
13. Analyze emerging trends in **AI governance, explainable AI (XAI)**, and **multimodal AI** as they relate to advanced CNNs.

Organizational Benefits

- Equips teams with cutting-edge **AI skills** for advanced visual data analysis, leading to more informed and strategic decision-making.
- Enables rapid prototyping and deployment of **AI-driven solutions** for various applications, fostering a culture of innovation and competitive advantage.
- Automates complex image and video processing tasks, streamlining workflows, reducing manual errors, and boosting overall productivity.
- Develops tailored CNN solutions for industry-specific challenges, leading to improved product features, enhanced customer experiences, and higher service quality.
- Optimizes model efficiency and leverages **transfer learning**, minimizing computational resource requirements and accelerating development cycles.
- Strengthens **fraud detection**, **quality control**, and **security systems** through highly accurate visual pattern recognition.
- Positions the organization at the forefront of **computer vision technology**, allowing for the development of innovative solutions that outperform competitors.

Target Audience

1. Data Scientists.
2. Machine Learning Engineers.
3. AI Researchers.
4. Computer Vision Engineers.
5. Software Developers.
6. AI Product Managers.
7. Robotics Engineers
8. Healthcare AI Professionals.

Course Outline

Module 1: Introduction to Advanced CNNs and Deep Learning Review

- Recap of foundational CNN concepts (convolution, pooling, activation functions).
- Understanding the limitations of traditional CNNs and the need for advanced architectures.
- Overview of the deep learning landscape and its impact on computer vision.
- Introduction to popular deep learning frameworks: TensorFlow and PyTorch.
- Setting up the development environment and data handling best practices.
- *Case Study: Evolution from LeNet to AlexNet and VGG, highlighting the increasing depth and complexity for improved image classification on ImageNet.*

Module 2: ResNet Architecture: Residual Connections for Deeper Networks

- Addressing the vanishing/exploding gradient problem in deep networks.
- In-depth exploration of residual blocks and identity mapping.
- Understanding different ResNet variants (ResNet-18, ResNet-50, ResNet-101).
- Implementing ResNet for image classification from scratch and using pre-trained models.
- Fine-tuning ResNet for specific downstream tasks.
- *Case Study: Using ResNet-50 for high-accuracy medical image classification (e.g., classifying X-ray images for pneumonia detection).*

Module 3: Inception Architecture: Efficient Multi-Scale Feature Extraction

- The concept of inception modules and parallel convolutions.
- Strategies for reducing computational cost within inception modules.
- Exploring InceptionV1 (GoogLeNet), InceptionV2, InceptionV3, and InceptionV4.
- Implementing Inception models for varied input scales and feature diversity.
- Auxiliary classifiers for improved gradient flow during training.
- *Case Study: Applying InceptionV3 for fine-grained image recognition, such as identifying specific bird species or car models in a large dataset.*

Module 4: EfficientNet: Scaling Model Efficiency and Performance

- Compound scaling principles (depth, width, and resolution scaling).
- Understanding the trade-offs between accuracy and computational efficiency.
- Exploring EfficientNet B0-B7 series and their optimal scaling factors.
- Implementing EfficientNet for resource-constrained environments and mobile applications.
- Benchmarking EfficientNet against other state-of-the-art models.
- *Case Study: Deploying EfficientNet-B0 on edge devices for real-time object detection in smart surveillance systems.*

Module 5: Advanced Optimization Techniques and Regularization

- In-depth review of optimizers (Adam, RMSprop, SGD with momentum).
- Batch Normalization: stabilizing training and accelerating convergence.
- Dropout, L1/L2 regularization, and early stopping for preventing overfitting.
- Learning rate schedulers and adaptive learning rates.
- Gradient clipping and other techniques for stable training.
- *Case Study: Analyzing the impact of different optimization strategies on the training convergence and generalization performance of a ResNet model on a custom dataset.*

Module 6: Transfer Learning and Fine-tuning Strategies

- The power of pre-trained models and feature extraction.
- Strategies for fine-tuning convolutional layers vs. fully connected layers.
- Domain adaptation and transfer learning for small datasets.
- Zero-shot and few-shot learning concepts.
- Practical considerations for selecting and adapting pre-trained models.
- *Case Study: Leveraging a pre-trained EfficientNet model to classify new categories of products in an e-commerce platform with limited labeled data.*

Module 7: Object Detection with Advanced CNNs

- Review of R-CNN, Fast R-CNN, and Faster R-CNN.
- Single-shot detectors: YOLO (You Only Look Once) and SSD (Single Shot MultiBox Detector).
- Anchor boxes, non-maximum suppression, and bounding box regression.
- Training custom object detection models with advanced CNN backbones.
- Evaluation metrics for object detection (mAP, IoU).
- *Case Study: Building an autonomous vehicle perception system using a ResNet-based Faster R-CNN for detecting pedestrians and traffic signs in real-time video feeds.*

Module 8: Semantic and Instance Segmentation

- Understanding the difference between classification, object detection, and segmentation.
- Fully Convolutional Networks (FCNs) for semantic segmentation.
- U-Net architecture for biomedical image segmentation.
- Mask R-CNN for instance segmentation.
- Applications of segmentation in various industries.
- *Case Study: Segmenting cancerous regions in MRI scans using a U-Net architecture, aiding in early diagnosis and treatment planning.*

Module 9: Generative Models and CNNs (Brief Introduction to GANs)

- The concept of Generative Adversarial Networks (GANs).
- Role of CNNs as generator and discriminator networks in GANs.
- Applications of GANs: image synthesis, style transfer, data augmentation.
- Challenges in training GANs and common solutions.
- Ethical considerations and biases in generative AI.
- *Case Study: Generating synthetic training data for a facial recognition system using a CNN-based GAN to improve model robustness and reduce bias.*

Module 10: Attention Mechanisms and Transformers in Computer Vision

- Introduction to attention mechanisms in deep learning.
- Self-attention and multi-head attention.
- Vision Transformers (ViT) and their growing importance.
- Integrating attention into CNN architectures.
- Comparing CNNs and Transformers for computer vision tasks.
- *Case Study: Implementing a hybrid CNN-Transformer model for improved image captioning, focusing on how attention helps the model focus on relevant image regions.*

Module 11: Deployment and MLOps for CNN Models

- Model serialization and deployment formats (ONNX, TensorFlow Lite).
- Optimizing CNN models for inference speed and memory usage.
- Introduction to MLOps principles for managing machine learning lifecycles.
- Monitoring deployed CNN models for performance degradation.
- Cloud deployment strategies (AWS SageMaker, Google AI Platform).
- *Case Study: Deploying a compact EfficientNet model on a mobile device for a real-time plant disease detection application, emphasizing performance optimization techniques.*

Module 12: Ethical Considerations and Bias in Computer Vision

- Understanding bias in training data and its impact on CNN models.
- Fairness, accountability, and transparency in AI.
- Techniques for mitigating bias and ensuring ethical AI development.
- Privacy concerns in computer vision applications.
- Regulatory landscape and responsible AI practices.
- *Case Study: Analyzing potential biases in a facial recognition system trained on a publicly available dataset and discussing strategies to improve fairness across demographic groups.*

Module 13: Advanced Topics and Future Trends in CNNs

- Latest research in neural architecture search (NAS).
- Graph Convolutional Networks (GCNs) and their applications beyond images.
- Explainable AI (XAI) for interpreting CNN decisions.
- Federated learning for privacy-preserving model training.
- Quantum computing and its potential impact on CNNs.
- *Case Study: Exploring recent advancements in few-shot learning for industrial defect detection, where limited defect samples are available.*

Module 14: Hands-on Project: End-to-End CNN Application Development

- Defining a real-world computer vision problem statement.
- Data collection, preprocessing, and annotation.
- Choosing and implementing an appropriate advanced CNN architecture.
- Training, validation, and hyperparameter tuning.
- Model evaluation, debugging, and deployment.
- *Case Study: Developing a custom object detection system for inventory management in a warehouse, from data labeling to model deployment and performance monitoring.*

Module 15: Training Methodology and Continuous Learning

- Interactive lectures and theoretical foundations.
- Practical coding exercises and lab sessions.
- Group projects and collaborative problem-solving.

- Access to curated datasets and computational resources.
- Best practices for staying updated with the rapidly evolving field of deep learning.
- *Case Study: Participants presenting their final projects and receiving constructive feedback, simulating a real-world project review process.*

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d. The course fee includes facilitation training materials, 2 coffee breaks, buffet lunch and A Certificate upon successful completion of Training.

e. One-year post-training support Consultation and Coaching provided after the course.

f. Payment should be done at least a week before commence of the training, to Fineskill Training Center account, as indicated in the invoice so as to enable us prepare better for you.

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

Start Date	End Date	Location	Price
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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