COURSE OVERVIEW IT0038
Semantic Segmentation

Course Title
Semantic Segmentation

Course Date/Venue
Session 1: July 21-25, 2025/Glasshouse Meeting Room, Grand Millennium Al Wahda Hotel, Abu Dhabi, UAE
Session 2: November 02-06, 2025/Tamra Meeting Room, Al Bandar Rotana Creek, Dubai UAE

H-STK© INCLUDED

3.0 CEUs (30 PDHs) AWARD

Course Reference
IT0038

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

This practical and highly-interactive course includes real-life case studies and exercises where participants will be engaged in a series of interactive small groups and class workshops.

This course is designed to provide participants with a detailed and up-to-date overview of Semantic Segmentation. It covers the improtance of semantic segmentation and the difference between image classification, object detection and segmentation; the types of image segmentation, fundamentals of image processing for segmentation and classical computer vision-based segmentation; the deep learning-based segmentation and apply evaluation metrics for semantic segmentation; the fully convolutional networks (FCN), U-Net architecture, contracting and expanding paths in U-Net; and the skip connections for preserving spatial information and applications of U-Net beyond medical imaging.

Further, the course will also discuss the deeplab models, atrous (dilated) convolutions for enlarged receptive fields and fully connected conditional random fields (CRFs) for refinement; the performance comparison with U-Net and FCN; the pyramid scene parsing network (PSPNet), combining detection and segmentation, attention mechanisms in segmentation and transformer-based semantic segmentation models; the multi-scale and context-aware segmentation and real-time semantic segmentation; the imbalanced data in semantic segmentation; the semantic segmentation in medical imaging, autonomous vehicles, autonomous vehicles and aerial and satellite imaging; and the model compression and deployment and GANs and semi-supervised learning for segmentation.

During this interactive course, participants will learn the imbalanced data in semantic segmentation; the semantic segmentation in medical imaging, autonomous vehicles and aerial and satellite imaging; the model compression and deployment, GANs and semi-supervised learning for segmentation; the AI and federated learning for privacy-preserving segmentation and advances in 3D semantic segmentation for AR/VR; the synthetic data for training robust segmentation models and handling privacy concerns in real-world applications; the explainability and transparency in AI predictions; and the best practices for responsible AI development.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply and gain a good working knowledge on semantic segmentation
- Discuss the importance of semantic segmentation and the difference between image classification, object detection, and segmentation
- Identify the types of image segmentation, fundamentals of image processing for segmentation and classical computer vision-based segmentation
- Explain deep learning-based segmentation and apply proper evaluation metrics for semantic segmentation
- Recognize fully convolutional networks (FCN), U-Net architecture, contracting and expanding paths in U-Net, skip connections for preserving spatial information and applications of U-Net beyond medical imaging
- Discuss the deeplab models, atrous (dilated) convolutions for enlarged receptive fields, fully connected conditional random fields (CRFs) for refinement and performance comparison with U-Net and FCN
- Recognize pyramid scene parsing network (PSPNet), combining detection and segmentation, attention mechanisms in segmentation and transformer-based semantic segmentation models
- Describe multi-scale and context-aware segmentation and real-time semantic segmentation
- Handle imbalanced data in semantic segmentation and apply semantic segmentation in medical imaging, autonomous vehicles, autonomous vehicles and aerial and satellite imaging
- Illustrate model compression and deployment and GANs and semi-supervised learning for segmentation
- Discuss AI and federated learning for privacy-preserving segmentation and advances in 3D semantic segmentation for AR/VR
- Illustrate synthetic data for training robust segmentation models and handle privacy concerns in real-world applications
- Describe explainability and transparency in AI predictions and apply best practices for responsible AI development

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of semantic segmentation for data scientists and machine learning engineers, software engineers, robotics engineers, AI product managers, data annotation specialists, medical imaging professionals, computer vision researchers, AI and deep learning practitioners and other technical staff.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Dr. Peter Lalos, PhD, MSc, BSc, is a **Senior IT**, **Telecommunications**, **Control & Electronics Engineer** with over **20 years** of extensive experience in the areas of **Enterprise Architecture** (**EA**) System, **OS Architectures**, **Cybersecurity & Enterprise Resilience**, **Network Security**, **IT Performance** Management, **IT Performance** Success Factors, Critical Factors for **IT Performance**, **IT Metrics** Management, **IT Matrix & Protocols**, **IT Service Management**, **IT Service Management Strategy**, **Information Technology Architectures**, **IT Disaster Recovery & Planning**, **IT Risk Management** Concepts, **IT Risk Management** Standard Approaches, I**T Risk Management** Planning, **IT Risk** Identification, **IT Risk Monitoring** & **Control**, Understanding & Contributing to Company's **IT Strategy**, **E-Communication & Collaboration Skills**, **Virtual Communication**, **Social Networking**, **Business Intelligence** Tools, **Application** Architecture, **Logical Applications**, **Interface**s & Services, Logical & Physical Components, **Portfolio** Management, **Application Security**, **Application Integration** Technologies & Strategies, **Solution Architecture** Patterns, **Web Applications** & Services, **Mobile** & **Cloud Applications**, **Blended Learning** Programs, **Web Programming**, **E-Commerce Strategies**, Advanced **Database Management** Systems, **Web Design**, **HCI**, 3D Animation, Multimedia Design, Gamification Techniques and Internal & External Auditing. Further, he is also well-versed in ACAD, ASP, PHP, JSP, MS Visual Studio, VB.NET, ASP.NET, Moodle administration, Design & Development, WAMP & LAMP, **Oracle Design**, Oracle JDeveloper, Oracle 11g, PL/SQL, MS SQL Server, MySQL, MS Access, HTML5, CSS, XML, XSD/ XSL, JavaScript, Ajax, Angular, jQuery, Web Services Adobe Suite, MS Office 2013, IIS Servers, MS Exchange Server & Apache Tomcat, Open Source CMS Expert (Xaraya, Joomla, Mambo) & Module Development, Open Source E-commerce Expert (oscommerce, Joomla & Virtuemart) and Module Development. Currently, he is the **IT Instructor/Subject Matter Expert** and **Course Developer** of the **University of Liverpool**, **UK**, wherein he lectures various courses in **Information Systems Program** and develop courses in Information Technology project management and security risk management.

During his career life, Dr. Lalos has gained his practical and field experience through his various significant positions and dedication as the **IT Manager**, **Bid Manager** & **S/W Developer**, **Project Manager**, **E-Learning Software Manager**, **Scrum Master**, **IT Professor**, **IT Lecturer/Trainer**, **Telecommunications**, **Control** & **Electronics Lecturer**, **Physics Instructor**, **Scientific Advisor**, **E-Learning Specialist**, **Undergraduate** & **Postgraduate Thesis Supervisor**, **IT Contractor**, **Laboratory Administrator**, **Moodle Expert** & **Administrator** and **Telecommunications Engineer** for various companies and universities such as the University of Greenwich, Empire State College, Roehampton University, University of East London, Athens Technology Center, University of Athens, **ShellGas**, Advanced Services Group (ASG), Piraeus University, Chemmedia Hellas Ltd., Conceptum S.A, IEK and Frontistirio Apopsi.

Dr. Peter has a **PhD** in **IT**, **Telecommunications**, **Control** & **Electronics** from the **University of Athens**, a **Master's degree** in **Information Technology** with **Web Technology** from the **University** of **Paisley**, **UK** and a **Bachelor's degree** in **Physics** from the **Aristotelian University** of **Thessaloniki**, **Greece**. Further, he is a **Certified Instructor/Trainer**, a **Scrum Master**, a **Certified Administrator**, an **LMS Specialist** and a **Certified Internal Verifier/Assessor/Trainer** by the **Institute of Leadership & Management** (**ILM**). He has further published several journals, participated as an author in various projects and conducted numerous trainings, courses, workshops, seminars and conferences internationally.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1

0730 – 0800	*Registration & Coffee*
0800 – 0815	*Welcome & Introduction*
0815 – 0830	***PRE-TEST***
0830 – 0930	***Understanding Semantic Segmentation*** *Definition and Importance of Semantic Segmentation • Difference Between Image Classification, Object Detection, and Segmentation • Types of Image Segmentation (Semantic, Instance, and Panoptic) • Real-World Applications (Medical Imaging, Autonomous Driving, Remote Sensing)*
0930 - 0945	*Break*
0945 – 1045	***Fundamentals of Image Processing for Segmentation*** *Image Representation: Pixels, Channels, and Color Spaces • Preprocessing Techniques: Resizing, Normalization, and Augmentation • Noise Reduction and Edge Detection • Introduction to OpenCV and Scikit-Image for Image Processing*
1045 - 1145	***Introduction to Classical Computer Vision-Based Segmentation*** *Thresholding-Based Segmentation (Global and Adaptive) • Region-Based Segmentation (Watershed Algorithm) • Edge-Based Segmentation (Canny Edge Detector, Sobel Filter) • Limitations of Traditional Segmentation Approaches*
1145 - 1230	***Introduction to Deep Learning-Based Segmentation*** *Why Deep Learning for Image Segmentation? • Role of Convolutional Neural Networks (CNNs) • Key Challenges in Semantic Segmentation • Overview of Modern Deep Learning Architectures*
1230 – 1245	*Break*
1245 – 1330	***Evaluation Metrics for Semantic Segmentation*** *Intersection over Union (IoU) / Jaccard Index • Dice Coefficient (F1 Score for Segmentation) • Pixel Accuracy vs. Mean Pixel Accuracy • Per-Class Accuracy and Mean IoU*

1330 - 1420	***Hands-On: Setting Up the Environment for Segmentation*** *Installing TensorFlow, PyTorch, and OpenCV • Using Jupyter Notebook for Image Segmentation • Loading and Displaying Images Using Matplotlib • Applying Basic Image Preprocessing Techniques*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day One*

Day 2

0730 – 0830	***Fully Convolutional Networks (FCN)*** *Introduction to FCN for Segmentation • Converting CNNs into Fully Convolutional Networks • Upsampling with Transposed Convolutions • Advantages and Limitations of FCN*
0830 – 0930	***U-Net: The Breakthrough in Biomedical Image Segmentation*** *Understanding U-Net Architecture • Contracting and Expanding Paths in U-Net • Skip Connections for Preserving Spatial Information • Applications of U-Net Beyond Medical Imaging*
0930 - 0945	*Break*
0945 – 1130	***DeepLab Family: Atrous Convolutions & Context Awareness*** *Introduction to DeepLab Models (DeepLabV1, V2, V3, V3+) • Atrous (Dilated) Convolutions for Enlarged Receptive Fields • Fully Connected Conditional Random Fields (CRFs) for Refinement • Performance Comparison with U-Net and FCN*
1130 - 1230	***Pyramid Scene Parsing Network (PSPNet)*** *Pyramid Pooling Module for Capturing Context Information • Multi-Scale Feature Learning in PSPNet • Encoder-Decoder Structure in PSPNet • Use Cases and Advantages over Other Models*
1230 - 1245	*Break*
1245 - 1330	***Mask R-CNN: Combining Detection & Segmentation*** *Instance Segmentation vs. Semantic Segmentation • Understanding the Region Proposal Network (RPN) • Mask Branch for Pixel-Wise Segmentation • Applications in Autonomous Driving and Object Tracking*
1330 - 1420	***Hands-On: Implementing U-Net for Semantic Segmentation*** *Training U-Net on Medical Imaging Dataset (e.g., Lung CT Scans) • Using Data Augmentation for Improving Segmentation Accuracy • Evaluating the Model Using IoU and Dice Coefficient • Visualizing Segmentation Results Using Matplotlib*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Two*

Day 3

0730 – 0830	***Attention Mechanisms in Segmentation*** *Introduction to Attention Mechanisms in Deep Learning • Self-Attention and Spatial Attention in CNNs • How Attention Improves Segmentation Performance • Implementing Attention U-Net for Better Feature Selection*
0830 – 0930	***Transformer-Based Semantic Segmentation Models*** *Introduction to Vision Transformers (ViT) • Segmentation Transformer (SETR) Architecture • Attention-Based Feature Extraction for Image Segmentation • Performance Comparison with CNN-Based Models*
0930 - 0945	*Break*
0945 – 1130	***Multi-Scale &Context-Aware Segmentation*** *The Importance of Multi-Scale Feature Extraction • Feature Pyramid Networks (FPN) in Segmentation • Context Aggregation for Improved Boundary Detection • Hybrid Approaches Combining CNNs and Transformers*
1130 - 1230	***Real-Time Semantic Segmentation*** *Challenges in Deploying Segmentation Models in Real Time • Lightweight Architectures for Mobile and Embedded Systems • Fast-SCNN and BiSeNet for Edge AI Applications • Performance Trade-offs: Accuracy versus Speed*
1230 - 1245	*Break*
1245 - 1330	***Handling Imbalanced Data in Semantic Segmentation*** *Why Class Imbalance is a Problem in Segmentation • Weighted Loss Functions (Focal Loss, Dice Loss) • Data Augmentation Strategies for Balancing Classes • Active Learning and Weakly Supervised Learning Techniques*
1330 - 1420	***Hands-On: Implementing DeepLabV3+ for Scene Parsing*** *Training DeepLabV3+ on Cityscapes Dataset (Autonomous Driving) • Using Pre-Trained Weights for Transfer Learning • Fine-Tuning Hyperparameters for Better Accuracy • Evaluating and Visualizing Segmentation Maps*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Three*

Day 4

0730 – 0830	***Semantic Segmentation in Medical Imaging*** *Tumor Detection and Organ Segmentation in CT/MRI Scans • AI-Based Skin Lesion Detection • Applications in Pathology and Disease Prediction • Regulatory Challenges in AI-Based Medical Diagnosis*
0830 – 0930	***Semantic Segmentation in Autonomous Vehicles*** *Understanding Scene Parsing for Self-Driving Cars • Detecting Roads, Pedestrians, and Traffic Signs • Integrating LiDAR and Camera Data for Robust Segmentation • Case Study: Tesla's AI-Based Driving Perception System*
0930 - 0945	*Break*
0945 – 1130	***Semantic Segmentation in Aerial & Satellite Imaging*** *Land Cover Classification Using Satellite Images • AI for Urban Planning and Environmental Monitoring • Detecting Floods, Wildfires, and Deforestation • Case Study: NASA's AI-Based Remote Sensing Models*
1130 - 1230	***Model Compression & Deployment*** *Reducing Model Size Using Pruning and Quantization • Deploying Segmentation Models on Edge Devices • Using TensorFlow Lite and ONNX for Mobile Deployment • Cloud-Based AI Segmentation Solutions*

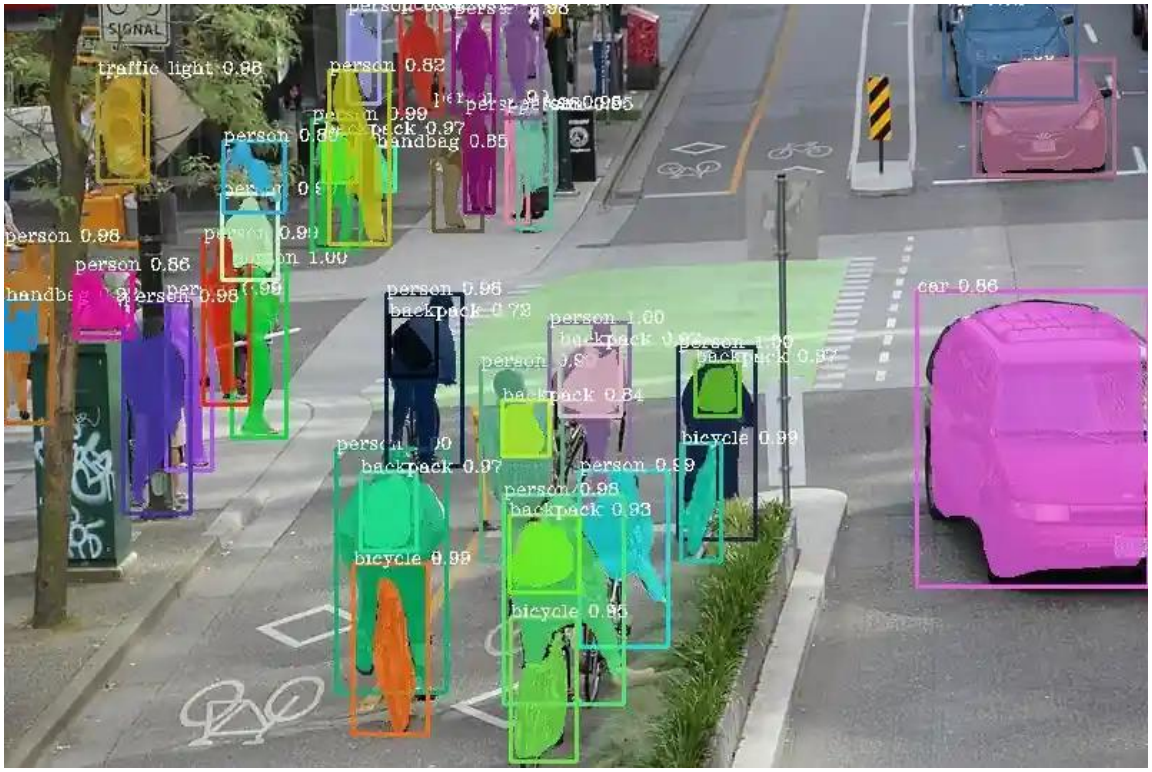
1230 - 1245	Break
1245 - 1330	***GANs & Semi-Supervised Learning for Segmentation*** *Using Generative Adversarial Networks (GANs) for Segmentation • Self-Supervised and Semi-Supervised Learning Techniques • Reducing Labeling Costs with Weak Supervision • Case Study: AI-Powered Super-Resolution in Image Segmentation*
1330 - 1420	***Hands-On: Implementing Fast-SCNN for Real-Time Segmentation*** *Training Fast-SCNN on Pascal VOC Dataset • Optimizing the Model for Low Latency • Deploying a Real-Time Segmentation Model on a Raspberry Pi • Comparing Performance with Other Lightweight Models*
1420 – 1430	***Recap*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Topics that were Discussed Today and Advise Them of the Topics to be Discussed Tomorrow*
1430	*Lunch & End of Day Four*

Day 5

0730 – 0930	***The Future of Semantic Segmentation*** *AI and Federated Learning for Privacy-Preserving Segmentation • Advances in 3D Semantic Segmentation for AR/VR • Synthetic Data for Training Robust Segmentation Models • Beyond Pixels: Understanding 3D Object Representations*
0930 - 0945	*Break*
0945 - 1130	***Ethical Considerations in AI-Based Image Segmentation*** *Bias and Fairness in Medical and Surveillance AI • Handling Privacy Concerns in Real-World Applications • Explainability and Transparency in AI Predictions • Best Practices for Responsible AI Development*
1130 – 1230	***Hands-on Final Project: Building an End-to-End Segmentation Pipeline*** *Selecting a Dataset and Model for Training • Preprocessing Data and Handling Class Imbalance*
1230 - 1245	*Break*
1245 - 1300	***Hands-On Final Project: Building an End-to-End Segmentation Pipeline (cont'd)*** *Training and Evaluating the Model on Custom Data • Deploying a Segmentation Model as a Web API*
1300 – 1315	***Course Conclusion*** *Using this Course Overview, the Instructor(s) will Brief Participants about the Course Topics that were Covered During the Course*
1315 – 1415	***POST TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Practical Sessions

This practical and highly-interactive course includes real-life case studies and exercises:-



Course Coordinator

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