

## Activity 3.6 - Training current RIs staff and user communities

**WP:** WP7 - Geosphere/Landsurface

**Title:** Data mining and deep learning for Geophysics

**Short description of the course:**

The course provides the basic concepts needed to apply deep learning methodologies to practical geophysics problems.

**Training objectives:**

- Basic knowledge of python language (needed to use the most common machine learning and deep learning software libraries)
- Basic machine learning concepts
- Machine learning models for geophysics
- Deep learning models for geophysics

**Location:** *Online*. Delivered by Università degli Studi di Salerno, DIEM;

**Address:** Via Giovanni Paolo II 132, 84084 Fisciano SA - Dipartimento di Ingegneria dell'Informazione ed Elettrica e Matematica Applicata (DIEM) - Laboratorio

**Period:** 30 June-3 July 2025

**Duration (days):** 4

**Course delivery method (online course/in-person/mixed):** *online*

**Number of the speakers:** 4

**Name of the speakers:** Vincenzo Carletti, Alessia Saggese, Diego Gragnaniello, Antonio Grieco

**Training modules:** 4

**Module 1: Introduction to Python**

*Lecturer: Prof. Vincenzo Carletti*

Introduction to the Python language. Passing parameters in Python. Positional parameters, default values, keyword parameters, positional/keyword parameters, positional-only and keyword-only

parameters. Functional aspects of Python. Functions as first-class entities: Functions as a parameter. Example: the sorted function. Definition of local functions. Lambda expressions.

## **Module 2: Introduction to Machine Learning**

*Lecturer: Prof.ssa Alessia Saggese*

Introduction to machine learning. Characteristics and areas of applicability of AI methodologies. Elements of decision theory. Error of bias and variance. Approaches based on handcrafted features. Preprocessing. Curse of dimensionality and dimensionality reduction. Correlation and confounding features. Introduction to the scikit-learn Python library.

## **Module 3: Advanced Machine Learning Models**

*Lecturer: Prof. Diego Gagnaniello*

Parametric and nonparametric models, linear models, logistic regression, Support Vector Machines, decision trees and Random Forest and hyper-parameter selection. Effect of regularization terms in the learning process.

## **Module 4: Introduction to Deep Learning**

*Lecturer: Antonio Greco*

Introduction to deep neural networks: non-linearly separable problems, training from data and representation learning. Convolutional neural networks and very deep approaches.

### **Syllabus:**

(1) Introduction to the Python language. Passing parameters in Python. Positional parameters, default values, keyword parameters, positional/overkeyword parameters, positional-only and keyword-only parameters. Functional aspects of Python. Functions as first-class entities: Functions as a parameter. Example: the sorted function. Definition of local functions. Lambda expressions.

(2) Introduction to machine learning. Characteristics and areas of applicability of AI methodologies. Elements of decision theory. Error of bias and variance. Approaches based on handcrafted features. Preprocessing. Curse of dimensionality and dimensionality reduction. Correlation and confounding features. Introduction to the scikit-learn Python library

(3) Parametric and nonparametric models, linear models, logistic regression, Support Vector Machines, decision trees and Random Forest and hyper-parameter selection. Effect of regularization terms in the learning process.

(4) Introduction to deep neural networks: non-linearly separable problems, training from data and representation learning. Convolutional neural networks and very deep approaches.

**Extra logistical needs:** PC and ad-hoc software are required

### Short introduction of each speaker:

*Prof. Vincenzo Carletti (Associate Professor)*

Graduated in Computer Engineering at the University of Salerno in 2012, he received his PhD in Information Engineering at the University of Salerno (Italy), under the supervision of prof. Mario Vento, and his PhD in Applied Computer Science at the University of Caen (Normandy, France), under the supervision of prof. Luc Brun in 2016. His doctoral thesis, entitled "Exact and Inexact Methods for Graph Similarity in Structural Pattern Recognition", was awarded as the best doctoral thesis by the Italian Association for Computer Vision, Pattern Recognition and Machine Learning (Italian chapter of the IAPR).

Since 2020 he has been vice-president of the Technical Committee #15 of the International Association for Pattern Recognition (IAPR).

Since 2021 he has been Delegate for ongoing orientation of DIEM.

His research focuses on exact and non-exact graph matching, graph-based neural networks and computer vision. He is the author of numerous articles published in international journals and conferences; among the most relevant are published works in IEEE Transactions on Pattern Analysis and Machine Intelligence, Pattern Recognition Letters and IEEE Access.

Since 2019 he has been Associate Editor for the journal Pattern Analysis and Applications.

He has reviewed for numerous international journals, including Pattern Recognition, Pattern Recognition Letters, IEEE Transactions on Pattern Analysis and Machine Intelligence.

*Prof. ssa Alessia Saggese (Associate Professor)*

Alessia Saggese received the Master's Degree (cum laude) in Computer Engineering from the University of Salerno in 2010.

In February 2014 she received a double PhD degree, jointly issued by the University of Salerno and the Ecole Nationale Supérieure d'Ingénieurs de Caen et Centre de Recherche (ENSICAEN), University of Caen Basse Normandie, France. The research project of her thesis was awarded by the "Università Italo Francese" – "Université Franco Italienne" (UIF-UI) within the Vinci Call and by the Gruppo Italiano Ricercatori in Pattern Recognition (GIRPR), the Italian chapter of the IAPR, for the best PhD thesis in Italy in the two-year period 2014-2016.

From April 2015 to December 2018 she was RTD-A at the Department of Information Engineering, Electrical Engineering and Applied Mathematics (DIEM) of the University of Salerno. From December 2018 to December 2021 she was RTD-B, from December 2021 to date she is Associate Professor at DIEM. Since 2018 she has been president of the Outgoing Orientation and Relations with Companies committee of DIEM and since 2019 she has been the delegate for Technology Transfer of DIEM.

Her research activities mainly concern computer vision algorithms and artificial intelligence for intelligent audio and video surveillance applications, cognitive robotics and autonomous driving vehicles. She is co-author of over 110 publications in international journals and conference proceedings, many of which in collaboration with prestigious foreign universities.

In 2016 and 2017 she is Co-Chair of a contest and a workshop organized within the IEEE ICPR and IEEE AVSS conferences, respectively. In 2018 she is Area Chair of the IEEE AVSS conference (section Surveillance Systems and Applications) and in 2021 of the ICIAP conference (section Brave New Ideas). She has served in the local Committee of several contests, workshops and international conferences (including GBR 2017 and CAIP 2019). She is member of several Program Committees, serves as reviewer for several international journals and has been Associate Editor of the IEEE Access journal since 2019.

#### *Prof. Diego Gragnaniello (Assistant Professor)*

Diego Gragnaniello received a Ph.D. in Electronics and Telecommunications engineering in 2015 from the University of Naples Federico II, Italy. His thesis was awarded the IEEE Biometrics Council (Italy Section Chapter) prize for the year's best thesis. In 2017, he joined the National Research Council of Italy (Cognitive System Laboratory). He's currently a Tenure-Track Assistant Professor (SSD ING-INF / 05 "Information Processing Systems") at the Department of Information and Electrical Engineering and Applied Mathematics (DIEM) of the University of Salerno.

He published about forty papers in international journals and conferences, participated in several research competitions, and achieved top scores. Furthermore, he contributed to numerous international research projects, including the DARPA projects MediFor (2016-2020) and SemaFor (2020-2024), MOST in the Spoke 6 (Connected and Autonomous Vehicles) (2022-2025) and in the Flagship B FULLROAD (2024-2025) project. He is Principal Investigator of the PRIN Project "Artificial Intelligence for the automatic interpretation of Ground Penetrating Radar data for subsoil risk assessment and disaster management" (AI4Dite).

His research activities are mainly focused on Computer Vision and Pattern Recognition, with particular interest in intelligent surveillance, including the detection of fire or adverse weather conditions, and autonomous driving applications. During his PhD and post-doc he worked on the recognition of counterfeit images, especially with applications to Biometric recognition systems, and on the classification of medical images for the recognition and follow-up of pathologies.

He holds the courses of Machine Learning and Artificial Intelligence for OMIC Data Analysis.

He is the DIEM's delegate to International activities.

He is the vice-chair of the Eurasp Signal and Data Analytics for Machine Learning Technical Area Committee. He serves as Associate Editor for the IEEE Transactions on Circuits and Systems for Video Technology. He served as Guest Editor of the Special Issue on "Advances in Digital Security: Biometrics and Forensics" for Elsevier Pattern Recognition Letters, as Managing Guest Editor of the Special Issue on "Adversarial Deep Learning in Biometrics & Forensics" for Elsevier Computer Vision and Image Understanding and the Special Issue on "Advances in Deep Learning" on MDPI Applied Science, for which he was invited to join the Topical Advisory Panel. He organized the International Workshop on Recent Advances in Digital Security: Biometrics and Forensics, 2019. He served as Technical Area Chair at European Signal Processing Conference since 2022.

*Prof. Antonio Greco (Assistant Professor)*

Antonio Greco graduated cum laude in Computer Engineering in 2014 at the University of Salerno (Italy). In March 2018 he received the PhD in Computer Science and Information Engineering from the same university. In March 2020 he became a Researcher RTD/A (SSD ING-INF/05 "Information Processing Systems") at the Department of Information and Electrical Engineering and Applied Mathematics (DIEM) at the University of Salerno, where he is now a Researcher RTD/B since November 2022. In the same department he has held the position of Delegate for Incoming Orientation since November 2022, while since May 2024 he has been a member of the Doctoral Board in Information Engineering.

Since 2014 he has been a member of the research group MIVIA Lab (Intelligent Machines for the Recognition of Video, Images and Audio) of the Department of Information and Electrical Engineering and Applied Mathematics of the University of Salerno, characterized by a strong vocation for international collaborations. His research activities are mainly focused in the areas of Computer Vision and Pattern Recognition and, more specifically, on the design, implementation and optimization of computer vision and deep learning algorithms (gender recognition, age estimation, ethnicity recognition, emotion analysis, fire detection, anomaly detection, people counting, object tracking, audio event recognition) in real time on data acquired by static devices (smart cameras, microphones) or in motion (drones, robots, autonomous vehicles). These activities were sometimes carried out in collaboration with European research groups, in particular with the University of Malta, the University of Groningen (Netherlands) and the University of Twente (Netherlands); in the latter he spent a total of 9 months (from January to April 2020 and from August 2021 to February 2022) as a Visiting Researcher,

collaborating in the teaching and research activities of the group within the Data Management and Biometrics Group, in the Faculty of Electrical Engineering, Mathematics and Computer Science.

Since March 2024 he is Associate Editor of the international journal Pattern Analysis and Applications. He is also a reviewer for over 25 international journals.

He has presented scientific papers in over 10 international conferences and served as Contest Chair in various international conferences. In particular, he organized the Guess the Age (GTA) Contest 2021 within the International Conference on Computer Analysis of Images and Patterns (CAIP); he co-organized the ONFIRE 2023 contest within the International Conference on Image Analysis and Processing (ICIAP); he co-organized the 2023 Pedestrian Attributes Recognition (PAR) Contest 2023 within the CAIP conference. He was also a member of the Local Committee of the International Workshop on Graph-based Representations (GBR), organized in Capri, Italy, from May 16 to 18, of the International Conference on Computer Analysis of Images and Patterns (CAIP), organized in Salerno, Italy, from September 2 to 6, 2019, of the IEEE Conference on Cognitive and Computational Aspects of Situation Management (CogSIMA), organized in Salerno, Italy, from June 6 to 10, 2022 and of the International Workshop on Graph-based Representations (GBR), organized in Salerno, Italy, from September 6 to 8. In 2021 he was Invited Speaker at the Workshop on CogSIMA Challenge Problems within the IEEE Conference on Cognitive and Computational Aspects of Situation Management (CogSIMA), with a talk entitled "Adding awareness to AI systems".