Curriculum Vitae et Studiorum

of Luciano Caroprese

Pursuant to articles 46, 47 and 76 of Presidential Decree No. 445/2000 and aware that false declarations are punished under articles 483, 495, 496 of the penal code and special laws on the matter, the undersigned Luciano Caroprese declares that the information reported in the following curriculum vitae corresponds to the truth.

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1 Education

- **Master's Degree in Computer Engineering**, obtained on October 18, 2004 with grade **110/110 cum Laude** at the University of Calabria.

  - *Thesis Title*: "A Logical Approach to the Problem of Integrating Inconsistent and Distributed Databases"
  - *Supervisor*: Prof. Sergio Greco
  - The thesis work concerned the study of the problem of database integration in *Peer to Peer* (*P2P*) systems. A P2P system does not provide any global schema. Each node controls its own database and can exchange information with other nodes. Queries are always executed at a node, which responds by integrating local data with data extracted from the remaining nodes. If the system is interpreted according to the traditional first-order semantics and if its topology presents cycles, computing the answer to queries can result in *undecidability* even when it is *decidable* on individual nodes. In the thesis work, a technique for the repair and querying of inconsistent databases was analyzed (adoptable for example in *Data Warehouse* systems). Furthermore, a semantics was proposed that guarantees the *decidability* of computing the answer to queries on P2P systems.

- **Ph.D. in Systems Engineering and Computer Science**, obtained on February 15, 2008 at the University of Calabria.

  - *Thesis Title*: "Declarative Semantics for Consistency Maintenance"
  - *Supervisor*: Prof. Ester Zumpano
  - The thesis work is developed in three parts. The first presents and studies *Active Integrity Constraints* (*AICs*). An active integrity constraint is essentially an integrity constraint that specifies the update actions to be executed on the database (insertions and deletions) when it violates the constraint itself. A declarative semantics for active integrity constraints was presented that defines the concept of founded repair. A founded repair is a minimal set of update actions specified and supported by active integrity constraints that makes the database consistent. The second part of the thesis focuses on analyzing the relationships between active integrity constraints and *Revision Programs*. Revision programs, introduced by Victor Marek and Miroslaw Truszczynski, constitute an alternative framework for repairing inconsistent databases. Revision programs define the concept of justified revision. In the thesis work it was demonstrated that every justified revision corresponds to a founded repair, but not vice versa. Therefore, two alternative semantics were defined, one for active integrity constraints and the other for revision programs. The first allows computing a more restricted set of repairs, the justified repairs, which correspond to justified revisions; the other allows computing a broader set of revisions, the founded revisions, which correspond to founded repairs. The introduction of the two semantics makes the two frameworks absolutely equivalent. One can pass from one to the other with simple syntactic transformations. The last part of the thesis presents a declarative semantics for the problem of *View Updating*. It concerns the translation of user view update requests into database updates. The intuition on which the new semantics is based is to exploit the knowledge already contained in the database in order to make a minimal set of modifications to it. It was demonstrated that updates on the database are computable by translating user requests and views into

an appropriate set of active integrity constraints and repairing the database with respect to that set.

2 National Scientific Habilitation (ASN)

- He has obtained the National Scientific Habilitation (ASN) to function as a Full Professor in the following Recruitment Field:
  - 09/H1 - INFORMATION PROCESSING SYSTEMS, corresponding to the new GSD 09/IINF-05 - INFORMATION PROCESSING SYSTEMS
- He has obtained the National Scientific Habilitation (ASN) to function as an Associate Professor in the following Recruitment Fields:
  - 01/B1 - COMPUTER SCIENCE, corresponding to the new GSD 01/INFO-01 - COMPUTER SCIENCE
  - 09/H1 - INFORMATION PROCESSING SYSTEMS, corresponding to the new GSD 09/IINF-05 - INFORMATION PROCESSING SYSTEMS

3 Research activity

He is currently an *Associate Professor* at the *Department of Engineering and Geology (InGeo)* of the *University "G. d'Annunzio" of Chieti-Pescara*, within the academic discipline SSD IINF-05/A - INFORMATION PROCESSING SYSTEMS.

From *28/10/2022* to *27/10/2025*, he was a *Researcher* at the *Department of Engineering and Geology (InGeo)* of the *University "G. d'Annunzio" of Chieti-Pescara*.

Since *23/05/2023* he is an *associate* with a collaboration agreement at *ICAR-CNR* in Rende (CS).

From *25/11/2019* to *24/11/2020* he was a *Researcher* at *ICAR-CNR* in Rende (CS).

Since *June 2021* he has a *collaboration agreement* with the Department of Mathematics and Computer Science of the University of Calabria for carrying out scientific, methodological and technical support activities in order to identify *"predictive maintenance techniques"*. His research activity in these periods has mainly concerned the following topics:

- *Machine Learning* and *Deep Learning*
- *Recommender Systems*
- *Online Auto Machine Learning*

From *01/11/2004* to *31/10/2007* he participated in the *Ph.D. Program* in Systems Engineering and Computer Science of the Department of Electronics, Computer Science and Systems (DIMES) of the University of Calabria (XX Cycle).
At the same Department he held *Research Grants* in the periods *01/02/2010 - 31/10/2011, 01/01/2012 - 30/11/2014, 01/01/2015 - 31/12/2017*.
The research activity carried out at the Department of Electronics Computer Science and Systems of the University of Calabria has mainly concerned the following topics:

- *Inconsistent Databases*
- *Data Integration Techniques*
- *Logic Programming with Preferences*
- *View Updating Techniques*
- *P2P Systems Modeling*
- *Abductive Systems*

The results of the research activities are documented by articles published in journals and conference proceedings. A brief description of each of the topics listed is reported below.

3.1 Machine Learning and Deep Learning

Since 2018 he has been dealing with Artificial Intelligence techniques based on *Machine Learning*. The topics of his studies range from classical Machine Learning models to advanced architectures based on Deep Learning (*Autoencoder*, *Generative Adversarial Network*, *Graph Neural Network*, *Reinforcement Learning*, etc.). Some of the main activities related to these topics are listed below. He was the instructor of the course *Data Analytics* at the Department of Information Engineering, Infrastructure and Sustainable Energy (DIIES) of the University of Reggio Calabria in the academic years 2019/2020 and 2020/2021. He was the instructor of the course *Advanced Deep Learning Models* for Ph.D. students in ICT at the University of Calabria in the academic years 2021/2022, 2022/2023 and 2023/2024. He was the instructor of the course *Fondamenti di Intelligenza Artificiale* at the Telematic University ECampus in the academic years 2020/2021, 2021/2022, 2022/2023 and 2023/2024. He was the instructor of the course *Scientific Programming*, in which he taught the fundamentals of Machine/Deep Learning, at the Department of Neuroscience, Imaging and Clinical Sciences, Master's Degree in Computational Cognitive Sciences, University "G. d'Annunzio" of Chieti-Pescara in the academic years 2022/2023, 2023/2024 and 2024/2025. He was also the instructor of the course *Data collection and analysis for research, and digital twin for maritime ecosystem*, for Ph.D. students in *Sustainable Blue Economy and One Health* at the Telematic University *Leonardo da Vinci* in the academic years 2023/2024 and 2024/2025.

He was *Invited Keynote Speaker* at the Workshop AI&BDvsPandemics (Artificial Intelligence and Big Data vs Pandemics) 2021, at the conference *IEEE BIBM* (*IEEE International Conference on Bioinformatics and Bio-medicine*) 2021, with the talk *"Graph Neural Networks in Healthcare"*. He carried out research activities within the project *HumanE-AI-Net* (*https://www.humane-ai.eu/*).

3.2 Recommender systems

Buying items on e-commerce systems, selecting a movie to watch or a song to listen to on streaming platforms, or making friends on social networks involves having to make choices among an enormous quantity of elements.

Recommender systems help users in their choices, suggesting to each one a few items considered to be of their interest. The most efficient and widespread recommender systems fall into the category of *collaborative filters*. These do not require any information related to users and items and are based on the idea that if two users in the past have mainly selected the same items, then they will have similar tastes. Therefore, most likely, each user could appreciate items that they had not yet had the opportunity to evaluate but that have been selected by the other. Collaborative filters present

enormous advantages but suffer from a serious problem: the *popularity bias* in the set of suggested items. In fact, they tend to suggest *very popular* items and neglect *less popular* ones. Because of this phenomenon, the suggestions of recommender systems are often considered *trivial*, because users are normally already aware of very popular items. On the contrary, the ability to recommend less popular items can make users discover niche and little-known items.

The research work related to this area aims to develop a set of techniques capable of mitigating the popularity bias phenomenon that characterizes recommender systems based on collaborative filters. Three techniques have been developed: i) a technique based on *oversampling* of less popular items during training to increase their exposure to the system, ii) one that involves the use of a *loss function* modeled so that the contribution that items make to the error depends on their popularity, and iii) one that consists of adopting an *ensemble* model obtained from the combination of a base model and a model specialized in handling low-popularity items.

In the context of recommender systems, a system capable of producing *synthetic data streams* with characteristics similar to real ones has also been designed. The system can be used to produce large datasets that can be used for training recommender systems.

The results of this research activity have been published in two articles accepted for publication in international journals [17, 18] and in an article presented at an international conference [76]:

3.3 Online Auto Machine Learning

In many application scenarios, machine learning systems must handle data streams (*streams*) whose properties can change over time. Recommender systems, for example, must normally process this type of data. A machine learning model is generally characterized by a set of hyperparameters η that defines its structure and a set of parameters Φ whose value is calculated during the training phase. In the case of a neural network, for example, some of the possible hyperparameters are i) the number of layers, ii) the number of neurons in each layer and iii) the activation functions used by each layer, while the parameters are the *weights* and *biases* of the neurons. While the search for optimal values of the parameters of a machine learning model is performed efficiently thanks to optimized versions of the *gradient descent algorithm*, the search for optimal values of hyperparameters is still a difficult and widely studied problem. The research activity related to this topic has resulted in the definition of a procedure for searching for optimal hyperparameters of machine learning models based on the *Nelder* and *Mead* algorithm, in the case where the data to be processed are time series whose characteristics change over time. In order to test the proposed approach, a synthetic data generator capable of producing realistic data streams has been designed and implemented.

The results of this study constitute the object of a work presented at an international conference [68].

3.4 Forecasting of meteorological and energy variables

Renewable energy sources, such as solar and wind, are becoming increasingly popular because they are clean and ecologically sustainable. Accurately estimating the energy production from these sources is essential to ensure their reliability. Energy production from renewable sources depends on environmental variables, such as solar radiation or wind speed. To ensure a constant and reliable supply of energy from these sources, it is therefore necessary to have accurate forecasts related to these variables.

The objective of the research work conducted in this area was the design and development of a neural model based on Deep Learning, capable of making forecasts related to six meteorological variables: GHI (Global Horizontal Irradiance), temperature, wind speed, wind direction, pressure and

humidity. The model requires as input a time series that, for each instant t belonging to an interval $[T-h, T]$, includes the real values of the variables and the corresponding forecasts made by the MM5 (Fifth-Generation Mesoscale Model) system at instant $t+k$. The model returns a new forecast related to the value of each variable at instant $T+k$. The experiments conducted showed that the values predicted by the model are more accurate than those returned by the MM5 system. A model was subsequently created that can make forecasts by processing exclusively the values returned by the MM5 model and which are available for any geographical location. The architectures of both models are based on a set of recurrent neural networks of the GRU (Gated Recurrent Unit) type. GRU networks are particularly suitable for analyzing time series because they are capable of capturing recurring patterns in the short and long term.

The forecasts related to climate variables were then used to make accurate forecasts related to energy variables (e.g. the energy production of photovoltaic panels).

Part of the research work related to this theme was conducted within the "*Energidrica*" project.

Furthermore, Dr. Caroprese is the scientific director of a Third-Party Research Contract that includes a set of activities related to this research theme within the PNRR project "PRE.C.E.DE".

The results of this research activity have been published in an article accepted for publication in an international journal [16] and in three articles presented at international conferences [72, 78, 79]:

3.5 Inconsistent databases

A database is *inconsistent* if it violates the integrity constraints that characterize it and that define a set of its properties. The problem of inconsistencies in databases is particularly felt in the context of integrating data from distinct information sources. In relation to this research theme, a technique has been defined that allows calculating *correct answers* to queries posed on potentially inconsistent databases. The proposed technique is based on the transformation of integrity constraints into disjunctive logic rules. The logic program thus obtained can be used (i) to define possible "repairs" of the database, that is to perform a minimal set of insertions and deletions that make it consistent, (ii) to produce consistent answers to queries, that is maximal answers that do not violate integrity constraints, without modifying the information content of the database itself. An evolution of this technique has been introduced which consists of introducing *active integrity constraints*, a simple but powerful mechanism that allows specifying "preferred" updates, that is the actions to be executed if an integrity constraint is not satisfied. Two different semantics have been proposed: a "prescriptive" semantics, in which only the specified actions can be executed and a "preference-based" semantics in which all actions that allow repairing the database are admissible, but explicitly defined actions are preferable.

The results of this study constitute the object of two works accepted for publication in international journals [1, 2], five works presented at international conferences [23, 32 38, 37, 65] and one work presented at a national conference [89].

3.6 Data integration techniques

In this research activity, the problem of integrating distinct databases was studied. In particular, some integration operators that allow combining data taking into account preference criteria on sources were analyzed. The problem of data integration was investigated in the context of incomplete (or indefinite) databases. An incomplete database is a database in which the lack of information is modeled through a special constant value (*null*). A new semantics has been proposed for the satisfaction of integrity

constraints in the presence of *null* values that is compatible with that implemented in modern DBMSs. A system that implements the proposed technique was subsequently developed.

The results of this study constitute the object of three works presented at international conferences [26, 25, 28].

3.7 Logic programming with preferences

This research activity concerned the study of logic languages with preferences. The two main approaches present in the literature ("Prioritized Logic Programming" and "Answer Set Optimization") were analyzed and a new technique was proposed that manages to avoid some problems encountered by previous approaches. In particular, the concept of *choice* was introduced in the context of logic programming with preferences. The proposed framework is based on the partition of preference rules into subsets, each of which is representative of a particular choice. The idea is that the evaluation of the choice can vary depending on the context in which it is made. An alternative semantics has also been proposed, which takes into account the admissibility of the specified choice options. This semantics is based on the study of the order of choices and on the role of constraints in the admissibility of choice options. A prototype of a system that implements the proposed semantics was then developed.

The results of this study constitute the object of three works presented at international conferences [31, 33, 34].

3.8 View Updating techniques

Not infrequently, databases store large volumes of data and are particularly complex. Normally, users and client applications do not have access to the entire system. Rather, access to data is guaranteed through views, virtual databases that consist of a set of relations defined by one or more queries on the extensional database. Querying a view does not represent a big problem. On the contrary, its updating (*view update*) is an extremely complex problem. The view update problem consists in translating a update request on a view into an update of the underlying database. Only such requests can in fact be physically executed. The main difficulty lies in the fact that the translation of a view update request into the corresponding repair does not always exist or there may be many. The purpose of the research work carried out was to study the view update problem for a wide class of views defined through logic programs and that admit derived existential predicates and integrity constraints. A derived existential predicate is defined through a logic rule containing variables in the body that do not appear in the head (*existential variables*). The objective of the research work was to propose a framework that translates a view update request into an update of the extensional database in accordance with the principle of *"least possible change"*.

The results of this study constitute the object of a work accepted for publication in an international journal [6] and of two works presented at international conferences [30, 44].

3.9 P2P systems modeling

In relation to this research line, the problem of integrating and querying databases in *peer to peer* (P2P) systems was studied. Each peer is first of all an autonomous system that manages its own database to support some application. The peer can then import data provided by other peers and export its own. It answers queries by integrating local knowledge with that extracted from the rest of the system. The database schema of each peer provides a set of integrity constraints that allow verifying the consistency of the local database. Normally, it is simple to ensure that local databases

are consistent with respect to their integrity constraints. However, it is necessary to ensure that data imported from the rest of the system do not corrupt them (do not make them inconsistent). The link between the various peers is fixed by 'mapping rules'. The mapping rules of a peer establish from which other peers it can import data, and what data it can import. A new semantics for mapping rules has been proposed that allows importing *maximal* subsets of atoms that do not violate integrity constraints. Numerous extensions of the base framework have subsequently been presented. These allow defining different forms of *preferences* on data and on peers.

A framework was then proposed in which mapping rules are used to import into each peer *minimal* subsets of data that make it consistent. In this case the import process is used to *repair* local databases.

These approaches were subsequently combined in a new framework that allows using both types of mapping rules simultaneously. Each peer will therefore be able to use mapping rules that allow repairing its own database by importing minimal sets of facts (*minimal mapping rules*) and mapping rules that allow integrating it by importing maximal sets of facts that do not make it inconsistent (*maximal mapping rules*).

Naturally there are many ways to integrate/repair the peers of a P2P system. A deterministic semantics (*Well Founded Semantics*) has therefore been defined that can assign to an atom an *undefined* truth value (in addition to *true* or *false*). This semantics allows calculating a *unique deterministic model* for each P2P system. The idea is that if an atom is *true* in one scenario calculated by the previous semantics and *false* in another scenario, then it will be *undefined* in the deterministic model. This semantics has allowed modeling each peer with a *normal logic program* for which the *Well Founded* model is computable *in polynomial time*. The peers therefore execute the integration process by exchanging their own Well Founded models. The presented approach has allowed realizing the prototype of a P2P system based on Well Founded semantics.

The results of this study constitute the object of three works accepted for publication in international journals [7, 8, 11], numerous works presented at international conferences [24, 29, 35, 36, 41, 42, 43, 45, 46, 47, 48, 49, 50, 51, 52, 54, 56] and two works presented at national conferences [88, 97].

3.10 Abductive systems

Abduction is an important form of *non-monotonic reasoning*. It is an *inference schema* aimed at deriving potential *explanations* of a set of *observations*, related to a certain environment, through a *theory* that models the environment itself. Normally an abductive reasoning can derive many explanations, some of which preferable to others. The identification of a subclass of *preferred explanations* is therefore a relevant and much studied problem. Following the principle of *'Occam's Razor'*, a typical approach is to identify as *preferred* those explanations that are, in a certain sense, *minimal*. In the literature, different concepts of *minimality* have been adopted (e.g. with respect to *inclusion* between sets or to the *cardinality* of sets). In *abductive logic programming* the *theory* is represented by a logic program, often disjunctive and with negation, interpreted using one of the standard semantics of logic programming (e.g. stable model semantics). The research activity related to this theme concerned the study of a *new measure of minimality of abductive explanations*. In particular, the concept of *degree of arbitrariness* of an explanation was defined. Intuitively, it defines the number of objects present in the abductive explanation that are arbitrarily fixed and that can therefore be replaced. The *preferred* explanations (*constrained explanations*) are those whose degree of arbitrariness is zero.

The results of this study constitute the object of two works accepted for publication in international journals [3, 5].

3.11 Fake News detection

The growing number of false information (*fake news*) has become a relevant problem and the effort of the scientific community in providing effective solutions capable of identifying them is considerable. It is not a recent problem, but with the advent of *social media* the nature of disinformation has evolved. The content of fake news is no longer just textual but also *multimedia* (*images*, *videos*, *audio*). Therefore, the identification of fake news requires techniques that effectively exploit and combine information extracted from different *multimedia channels*. These techniques are called 'multimodal'. In the literature there are numerous models capable of effectively detecting whether texts, images or videos are authentic or not, but there are still few solutions capable of processing multimodal content.

In this area, the most recent multimodal techniques for detecting fake news on social media based on Deep Learning (DL) models have been analyzed. The neural architectures and fusion strategies adopted have been analyzed, highlighting their advantages and main limitations.

The results of this research activity have been published in an article accepted for publication in an international journal [15].

3.12 Deep Learning models for audio signal analysis

In the sector of developing *automatic surveillance systems*, *video signals* have been considered for a long time almost exclusively. Although these are rich in information, their acquisition and processing might not satisfy some constraints related, for example, to the limited availability of *computational resources* or to the existence of norms on *privacy*. In an attempt to overcome these limitations, surveillance systems based on *audio signals* have emerged. In this area, a Deep Learning model capable of detecting anomalies in an environment frequented by human operators, by analyzing the audio stream captured by an environmental microphone, has been developed. The core of the model consists of an *autoencoder* that processes the *spectrograms* of the audio stream with a series of convolutional layers. The idea on which this approach is based is that an environment in a certain time slot is characterized by audio patterns that repeat over time (e.g. an office in the afternoon will be characterized by many clicks from pointing devices and keyboards, from the noise of printers and by some conversation in calm tones). The model learns these patterns and is able to detect new ones (e.g. a scream, the breaking of an object, etc.). The latter correspond to anomalous situations and are associated with a high reconstruction error of the autoencoder. This approach is particularly interesting because it is based on unsupervised learning. It is therefore not necessary to have a labeled dataset (normally difficult to obtain). It will be sufficient to leave the model listening, for a sufficiently long period of time, in the environment to be monitored. The detected audio stream will be used to train the model. After this phase, the model can be used to detect anomalies.

The results of this research activity have been published in an article accepted for publication in an international journal [14].

3.13 Federated Learning in the medical field

Federated learning is a machine learning paradigm that allows training deep learning models using large datasets distributed across multiple *data-centers*, keeping sensitive data within their respective local structures. This approach offers a significant advantage: it guarantees data privacy by avoiding the transfer of sensitive information to a single central location. In federated learning, only model parameters are shared, allowing the information content of distributed data to be exploited without compromising their confidentiality. In the medical field, federated learning is emerging as an ideal

solution to support diagnoses and early detection of serious pathologies. For example, for brain, breast and lung cancer, timely identification of anomalous formations is essential to improve the effectiveness of therapies and increase the life expectancy of patients. However, the processing and sharing of medical images require protocols that respect high privacy standards. In this context, federated learning allows training algorithms on images from multiple institutions without transferring data. This reduces the risk of privacy violations and ensures the robustness of models.

The results of this research activity have been published in three articles presented at an international conference [73, 74, 75]:

3.14 Neurosymbolic and explainable approaches to Artificial Intelligence

Cognitive science scientifically studies mental processes through different disciplines, from psychology to philosophy, from neuroscience to computer science. In particular, in the field of Artificial Intelligence, an interesting debate has emerged on how best to represent cognitive processes: whether through a vast network of simple elements (neurons) or through high-level structures such as symbols, schemas and rules. This has led to two complementary approaches: the symbolic one, based on logic and deductive reasoning, and the subsymbolic one, based on neural networks. In this context, the research work presents an innovative neurosymbolic framework that combines the two approaches, combining reinforcement learning with logic programming. The goal is to allow an agent to learn the cause-effect rules that govern an environment by observing the facts that occur, without any prior knowledge. The agent observes the facts present in the environment at a given moment and tries to predict what new facts will occur next. To do this, it constructs and progressively refines a logic program that models the observed cause-effect relationships. The agent's predictions are then compared with what actually happens, allowing it to improve its own model through reinforcement learning. A particularly innovative aspect is the framework's ability to manage dynamic environments, where cause-effect rules can change over time. The agent is able to adapt its own model when it observes new behavior patterns, maintaining an accurate and up-to-date understanding of the environment. Experimental results show that the agent manages to learn accurate models that not only correctly predict future facts but also provide a correct logical explanation of them. This approach opens new perspectives in various application domains, from the analysis of clinical symptoms to industrial predictive maintenance.

The results of this research activity have been published in an article presented at an international conference [81].

3.15 Temporal Point Processes (TPPs)

The concept of *Temporal Point Process* (*TPP*) is used for modeling *events* that occur in a continuous time interval. These events can pertain to different domains. Think, for example, of arrivals of phone calls, volcanic eruptions, heart attacks, online purchases, etc. The main characteristic of the events of a TPP is that they occur randomly. The model tries to capture this randomness through a probability distribution. In particular, a conditional intensity function $\lambda(t|H_t)$ is defined, which represents the frequency of occurrence of events (events in the unit of time) in the infinitesimal interval $[t, t + \Delta t)$ conditioned on the history H_t (the sequence of time instants preceding t in which past events occurred). Then a conditional probability density function $f(t|Ht)$ is defined, which represents the probability that the next event occurs in the infinitesimal interval $[t, t + \Delta t)$ conditioned on the history H_t, and a conditional cumulative probability distribution $F(t|H_t)$, which returns the probability that the next event occurs before instant t, conditioned on the history H_t. To model a TPP it is sufficient to derive

one of the three functions, because the others are derivable from the known one. Normally, one operates on the conditional intensity function $\lambda(t|H_t)$. Natural extensions of the TPP are: i) *Marked Temporal Point Process* (*MTPP*), in which each event is associated with a type, ii) *Spatio-Temporal Point Process* (*STPP*), which models processes in which events occur at different geographical points and iii) *Marked and Spatio-Temporal Point Process* (*MSTPP*). There are classical approaches to modeling TPPs (and MTPPs, STPPs and MSTPPs), but recently powerful techniques based on Deep Learning models have been developed: *Recurrent Neural Networks* (*RNN*), *Variational Autoencoders* (*VAE*) and *Deep Reinforcement Learning* (*DRL*). In each of these approaches, essentially the conditional intensity function is modeled with a neural architecture that is trained using the history of events.

The results of this research activity have been published in an article accepted for publication in an international journal [19].

3.16 Classification of skin lesions

Cutaneous melanoma represents the most lethal form of skin tumors and, although it is incurable in advanced stages, it has a high survival rate if diagnosed early. However, the classification of skin lesions remains a challenge due to their ambiguous nature.

In this context, research work was conducted that led to the development of MultiExCam, a new hybrid and explainable architecture for the classification of skin lesions that combines machine learning and deep learning techniques. The approach uses a convolutional neural network both for feature extraction and for an initial classification, then integrating the extracted features with others created manually to train four additional machine learning models. An ensemble model, implemented as a feed-forward neural network, aggregates these features and predictions to produce the final classification. To improve interpretability, the architecture employs GradCAM to visualize critical regions in input images and SHAP to evaluate the contribution of individual features to predictions. This approach not only achieves an AUC of 0.97 and an F1-score of 92%, but significantly improves the transparency and reliability of AI-based decisions in a medical context. The validity of the architecture has been demonstrated through a series of experiments on a large dataset of dermatoscopic images, confirming both the accuracy of predictions and the ability to provide understandable explanations for the decision-making process.

The results of this research activity have been published in an article accepted for publication in an international journal [20].

3.17 Explainable Artificial Intelligence approaches for monitoring elderly individuals

The prediction or timely detection of falls in elderly individuals is essential to reduce the risk of serious consequences such as disabling fractures and psychological problems, which in some cases can lead to death. Artificial Intelligence has proven to be a particularly effective tool for this problem, allowing the development of automatic fall detection systems with high accuracy and rapid response times. In this area, a systematic review of Fall Detection Systems for the Elderly that use both standard Artificial Intelligence techniques and Explainable Artificial Intelligence (XAI) approaches has been conducted. The research analyzes the state of the art and outlines future perspectives, highlighting the importance of artificial intelligence systems that combine high accuracy, robustness and transparency.

The results of this research activity have been published in an article accepted for publication in an international journal [21].

3.18 Soil liquefaction

Soil liquefaction is a phenomenon that occurs during earthquakes when the soil loses its strength and stability, potentially causing the settlement or collapse of overlying structures. To assess the liquefaction risk of a site, it is essential to determine two key parameters introduced by Ishihara in 1985: H1, which represents the thickness of the non-liquefiable surface layer, and H2, which indicates the thickness of the potentially liquefiable underlying layer. The accurate definition of these parameters is crucial but complex, and recently deep learning models have shown great potential in this field. However, training these models requires large amounts of data, difficult to obtain in the geotechnical sector due to the high costs of field investigations. The research that was conducted in this area addressed this challenge by developing an innovative generator of synthetic soil profiles, based on statistical analysis of real cases in the Emilia-Romagna region. This tool allows creating a large dataset of artificial profiles that maintain the statistical characteristics of real cases. The effectiveness of the approach has been demonstrated by training deep learning models on synthetic data and testing them on real cases. The results were excellent, with 98% accuracy in estimating H1 and 83% for H2, confirming that the models have effectively captured the expertise of sector experts encoded in the generated synthetic data.

The results of this research activity have been published in an article accepted for publication in an international journal [22].

4 Recent research activities and submitted articles

This section presents the most recent research activities that have led to the submission of articles for publication in international scientific journals. These works are currently under review.

4.1 Large Language Models (LLMs)

Large Language Models (LLM) are complex systems, based on artificial neural networks, used to interpret and generate text creatively. The research activity in this area mainly concerns the development of empathic bots capable of interacting with users in an emotionally significant way. The goal is to implement systems capable of analyzing user messages, detecting their emotions and providing coherent, transparent and justified responses. These bots will be able to return outputs adherent to specific *psychological strategies* and will provide detailed explanations on the *reasons/objectives* behind each response.

The results of this research activity are reported in the following article submitted to an international scientific journal:

- L. Caroprese, E. Zumpano, *XBot: An Explainable and Empathetic GPT-based Chatbot.* Neural Computing and Applications, Springer.

5 Scientific collaborations

- Since 2007 he has been collaborating with *Prof. Miroslaw Truszczynski* (*Department of Computer Science, University of Kentucky - Lexington, KY*) on research activities related to the management of *inconsistent databases* and *knowledge representation.*

- From 2007 to 2009 he collaborated with *Prof. Peter Sloot* (*Faculty of Science, University of Amsterdam*) on research activities related to the definition of a *logical framework for detecting anomalies in algorithms for modeling drug resistance properties.*

- Since 2015 he has been collaborating with *Prof. Miroslaw Truszczynski* (*Department of Computer Science, University of Kentucky - Lexington, KY*) on research activities related to the *definition of a logical framework for managing preferences on databases.*

- Since 2017 he has been collaborating with Prof. *Pierangelo Veltri* (*Magna Graecia University of Catanzaro*) on research activities related to the *development of tools for the analysis of medical images to support diagnostic processes and surgical interventions and approaches for the classification of images related to melanomas and dysplasias.*

- Since 2017 he has been collaborating with Prof. Domenico Ursino, DII Polytechnic University of Marche on research activities related to knowledge representation and neural networks.

- Since 2019 he has been collaborating with *Prof. Bart Bogaerts* (*AI Lab, Vrije Universiteit Brussel, Belgium*) on research activities related to the *computation of preferred explanations in the context of abductive logic programming.*

- Since November 2019 he has been collaborating with *Prof. Giuseppe Manco*, Research Director of *ICAR CNR* on research activities related to *i) Machine Learning, ii) Deep Learning, iii) Recommender Systems and iv) Online Auto Machine Learning.*

- Since October 2020 he has been collaborating with *Prof. Holger H. Hoos* (*RWTH Aachen University*) within the European project Humane AI on research activities related to the theme *Online Auto Machine Learning.*

- Since October 2020 he has been collaborating with *Prof. João Gama* (*LIAAD-INESC TEC, University of Porto*) within the European project Humane AI on research activities related to the theme *Online Auto Machine Learning.*

6 University Teaching Activities in Italy and Abroad

Has been carrying out teaching activities continuously since the academic year 2004/2005.
Collaborates or has collaborated with the teaching activities of the University "G. d'Annunzio" of Chieti-Pescara, the University of Calabria, the University of Reggio Calabria, the Leonardo da Vinci Telematic University and the ECampus Telematic University.

6.1 Teaching Assignments

Has been or is currently instructor of the following *doctoral courses (Ph.D.)*:

- *Advanced Deep Learning Models*, co-instructor Prof. Ester Zumpano, *Ph.D. in ICT*, University of Calabria, Cycles XXXV, XXXVI, XXXVII (AY 2021/2022, **10 hours**), Cycles XXXVI, XXXVII (AY 2022/2023, **10 hours**), Cycles XXXVII, XXXVIII (AY 2023/2024, **6 hours**).

  Description:

In this course two advanced Deep Learning models were presented: Graph Neural Networks (GNNs) and Deep Reinforcement Learning (DRL). GNNs are Deep Learning models used when input data does not have a sequential structure (e.g., texts) or matrix structure (e.g., images), but can be modeled with a graph. GNNs allow associating to each node a data structure that summarizes its properties (embedding) and that is calculated by aggregating (and processing) the information of the node itself with that of neighboring nodes. This process can be executed with a message-passing mechanism. Embeddings can be used to make predictions related to nodes, edges or the entire graph. Deep Reinforcement Learning models combine the Reinforcement Learning (RL) paradigm with Deep Learning. In a Reinforcement Learning system, an agent operates in an environment by executing actions that alter the state of the environment itself. The agent receives rewards (or penalties) and has the goal of maximizing its gains. The decisions made by the agent (policy) are derived from the outputs of a Deep Learning model that is trained to return the most advantageous actions. Deep Reinforcement Learning models achieve performance superior to that of human beings called upon to perform the same tasks.

- *Data collection and analysis for research, and digital twin for maritime ecosystem* (**12 hours**), *Ph.D. in Sustainable Blue Economy and One Health*, *Leonardo da Vinci* Telematic University, cycles XXXIX, XL (AY 2023/2024, 2024/2025).

  Description:
  The course has the following objectives: i) provide the skills for data acquisition in different marine contexts through differentiated methodologies; ii) develop the necessary knowledge for data management and implementation of machine learning models in the context of 'blue economy', iii) transmit the skills to understand the complex dynamics of ecosystems through the use of digital twin.

Has been or is currently instructor of the following *university courses*:

- *Informatica* - Department of Engineering and Geology, University "G. d'Annunzio" of Chieti-Pescara, **60 hours**, **6 CFU**, AY 2022/2023, AY 2023/2024, AY 2024/2025.

  Degree Programs
  Bachelor's Degree in Civil Engineering (L-23)
  Bachelor's Degree in Biomedical Engineering (L-9)

  Learning Objectives
  The course aims to provide fundamental notions related to computer architecture, information representation, algorithms and programs. It also aims to provide a correct methodology for implementing programs in programming languages. The Informatica course is shared between Civil Engineering (L-23) and Biomedical Engineering (L-9).

  Program
  i) Introduction to computer architecture, ii) Information representation in computers, iii) Problems, algorithms and programs, iv) Flowcharts and pseudo-code, v) Logical operators, vi) Control structures if-then-else and loops, vii) Introduction to Matlab programming environment, viii) Main mathematical functions in Matlab, ix) Arrays and matrices in Matlab, x) Files in Matlab, xi) Scripts and custom functions, xii) Data import and export, xiii) 2D and 3D graphics in Matlab, xiv) The Python language, xv) Basic operations, functions and libraries, xvi) Similarities

and differences between Matlab and Python.

- *Laboratorio di Informatica - Basi di Dati - GIS - BIM* - Department of Engineering and Geology, University "G. d'Annunzio" of Chieti-Pescara, **30 hours**, **3 CFU**, AY 2023/2024, AY 2024/2025.

  Degree Program
  Bachelor's Degree in Technical Professions for Construction and Territory

  Learning Objectives
  The course aims to provide knowledge related to Databases, GIS Systems and BIM systems. The lecture contents will cover: i) database design and querying, ii) fundamentals of geodesy, topology and use of GIS systems (Quantum GIS), and iv) introduction to BIM systems.

  Program: i) Introduction to Databases, ii) Database Design (Entity-Relationship diagram and logical schema), iii) Database Querying (SQL language), iv) Database Development in Microsoft Access, v) Fundamentals of geodesy, vi) Fundamentals of topology, vii) Vector layers and raster layers, viii) Use of Quantum Gis, ix) Introduction to BIM systems.

- *Scientific Programming* - Department of Neuroscience, Imaging and Clinical Sciences, University "G. d'Annunzio" of Chieti-Pescara, **64 hours**, **8 CFU**, AY 2022/2023, AY 2023/2024, AY 2024/2025.

  Degree Program
  Master's Degree in Computational Cognitive Science (LM-55)

  Learning Objectives
  The course aims to provide knowledge on languages, programming techniques, algorithms and data structures useful for scientific computing and knowledge of techniques for Machine Learning and Deep Learning.

  Program
  i) General Information, ii) The Python language, iii) Machine Learning, iv) Support Vector Machine, v) k-Nearest Neighbors, vi) Linear Regression and Logistic Regression, vii) Decision Trees and Random Forest, viii) Unsupervised Learning, ix) Introduction to Artificial Neural Networks, x) Convolutional Neural Networks, xi) Recurrent Neural Networks, xii) Introduction to Reinforcement Learning.

- *Data Analytics* - DIIES, University of Reggio Calabria,
  AY 2019/2020, AY 2020/2021.
- *Fondamenti di Intelligenza Artificiale* - ECampus Telematic University,
  AY 2021/2022, AY 2022/2023, AY 2022/2024.
- *Informatica per le Scienze Sociali* - DISPeS, University of Calabria,
  AY 2017/2018, AY 2018/2019.

- *Sistemi Informatici per il Turismo* - DIScAG, University of Calabria,
  AY 2017/2018, AY 2018/2019, AY 2019/2020.
- *Strumenti per la Progettazione di Sistemi Informativi* - course A (2 CFU) of the Faculty of Engineering of the University of Calabria,
  AY 2009/2010.
- *Strumenti per la Progettazione di Sistemi Informativi* - course B (2 CFU) of the Faculty of Engineering of the University of Calabria,
  AY 2009/2010.

Has held the following *teaching assignments* in *University Masters*.

- Year 2005, *teaching assignment* project *Master M.ENT.E* (Managment Integrated of Enterprice) PON Agroindustria n. 12979.
- Year 2005, *teaching assignment* project *Master* within the FAR Call (Research Incentive Fund) Rectoral Decree n. 130/Ric of February 16, 2004: "Research and Training Projects in the ICT sector".

Has been *teaching assistant* of the following *university courses*:

- *Fondamenti di Informatica I* (4 CFU) of the Faculty of Engineering of the University of Calabria, AY 2004/2005, AY 2005/2006, AY 2012/2013, AY 2013/2014, AY 2015/2016, AY 2016/2017, AY 2017/2018 (Instructor E. Zumpano).
- *Progettazione di Sistemi Informativi* (5 CFU) of the Faculty of Engineering of the University of Calabria, AY 2005/2006, AY 2006/2007, AY 2007/2008 (Instructor E. Zumpano).
- *Basi di Dati e Conoscenza* (5 CFU) of the Faculty of Engineering of the University of Calabria, AY 2004/2005, AY 2006/2007 (Instructor S. Greco).
- *Basi di Dati* (5 CFU) of the Faculty of Letters and Philosophy of the University of Calabria, AY 2005/2006 (Instructor E. Zumpano).
- *Sistemi Informativi e Basi di Dati* (6 CFU) of the Faculty of Engineering of the University of Calabria, AY 2005/2006 - AY 2006/2007, AY 2014/2015, AY 2015/2016, AY 2016/2017, AY 2017/2018 (Instructor E. Zumpano).
- *Algoritmi e Strutture Dati* (6 CFU) of the Faculty of Engineering of the University of Calabria, AY 2007/2008, AY 2008/2009 (Instructor S. Flesca).
- *Introduzione all'Informatica* (2 CFU) of the Faculty of Engineering of the University of Calabria, AY 2007/2008 (Instructor I. Trubitsyna).
- *Fondamenti di Informatica I* (4 CFU) of the Faculty of Engineering of the University of Calabria, AY 2008/2009, AY 2009/2010, AY 2010/2011, AY 2011/2012, AY 2012/2013 (Instructor F. Scarcello).
- *Sistemi Informativi Aziendali* (Courses A and B) of the Faculty of Engineering of the University of Calabria, AY 2009/2010 (Instructor E. Zumpano).
- *Sistemi Informatici per il Turismo* - Department of Political and Social Sciences University of Calabria, AY 2014/2015, AY 2015/2016, AY 2016/2017 (Instructor E. Zumpano).

6.2 Seminar Activities

Gave a seminar as part of the *RicerCaffè* series of meetings organized by the Department of Engineering and Geology (InGeo) of the University "G. d'Annunzio" of Chieti-Pescara for all Faculty and Doctoral Students of the Department, entitled: *"AI & LLM"*.

Description
The seminar offered an introduction to Artificial Intelligence and Large Language Models. During the meeting, the theoretical foundations of AI were illustrated, distinguishing between traditional computer systems and artificial intelligence systems. Particular attention was paid to the comparison between the logical approach (rule-based) and the connectionist approach (neural network-based) to AI. The seminar explored the functioning of artificial neural networks, explaining the structure of the artificial neuron, the organization in deep neural networks and supervised training techniques. In the second part, attention shifted to large language models (LLM) such as ChatGPT and Claude, analyzing their architecture, functioning and comparing their computational complexity with that of the human brain.

6.3 Thesis Supervisor or Co-supervisor for Master's Degree Theses

- *Master's Degree in Civil Engineering*
  Role: *Co-supervisor*
  Student Name and Surname: *Virginio Cocciaglia*
  Thesis Title: *"Estimation of energy production from renewable sources: integration of artificial intelligence in numerical approaches"*
  Academic Year: *2021/2022*

- *Master's Degree in Civil Engineering*
  Role: *Co-supervisor*
  Student Name and Surname: *Pierfrancesco Ricciardi*
  Thesis Title: *"The use of AI in predicting meteorological variables involved in energy production from renewable sources"*
  Academic Year: *2023/2024*

- *Master's Degree in Civil Engineering*
  Role: *Co-supervisor*
  Student Name and Surname: *Francesco Cantile*
  Thesis Title: *"Photovoltaic and Wind: how Environment and Technology influence energy production"*
  Academic Year: *2024/2025*

7 Documented training or research activity at qualified Italian or foreign institutions

- Participated in the school *ESSLLI 2006* (18th European Summer School in Logic, Language and Information, University of Malaga, 31 July - 11 August, 2006), reserved for Ph.D. students.

- Carried out a period of study and research at the *University of Lexington (Kentucky - USA)* (April 2007 - July 2007), during which he worked with Prof. *Mirosław Truszczyński*. The

research activity concerned the comparison between Revision Programming and Active Integrity Constraints.

- Carried out a period of study and research at the *University of Lexington (Kentucky - USA)* (November 2015) during which he worked with *Prof. Mirosław Truszczyński*. The objective of the activity was the definition of a logical framework for managing preferences on databases. He defined the logical foundations on which the framework is based and developed an algorithm for ordering tuples based on user-provided preferences.

- Carried out a period of study and research at *Carleton University (Ottawa - Canada)* (December 2015) during which he worked with *Prof. Leopoldo Bertossi*. The objective of the activity was to study the relationship between abduction and causality on databases. He defined the logical foundations that link the two concepts and developed an algorithm for calculating the facts that are 'causes' of the answer to a query.

- Carried out a period of study and research at the *AI Lab, Vrije Universiteit Brussel* (May 2018) during which he worked with *Prof. Bart Bogaerts*. The objective of the activity was the definition of techniques for computing preferred explanations in the context of abductive logic programming.

8 Implementation of Project Activities

Has been continuously collaborating since 2004 with ICT companies, Universities and Research Institutes as *scientific coordinator*, *researcher*, *team leader*, *developer* or *designer*.

Has been included in the national list of *Innovation Managers* compiled by the *Ministry of Economic Development* (*MISE*) with Director's Decree of November 6, 2019.

Has been *scientific coordinator*, *designer*, *developer* or *team leader* of the following projects:

- *MULTI-TWIN*
  (*Scientific Coordinator*)
  Scientific coordinator of the PNRR project "Intelligenza artificiale a supporto di analisi MULTI-rischio mediante digital-TWIN (MULTI-TWIN)", related to the Public Call for Cascade Tender issued with D.R. n. 1433 of 17/04/2024 within Spoke 5 "Environment & Natural Disasters" Project "National Centre for HPC, Big Data and Quantum Computing", funded under the National Recovery and Resilience Plan, Mission 4 "Education and research" – Component 2 "From research to business" – Investment 1.4, funded by the European Union – NextGenerationEU, Project Code CN00000013, CUP H93C22000450007.
  Please refer to Section 9 for further details.

- *AI4MOOC*
  (*Scientific Coordinator*)
  Scientific coordinator of the PNRR project "Artificial Intelligence for Massive Open Online Courses (AI4MOOC)", Program Tech4You (code ECS 00000009), MISSION 4 COMPONENT 2, "From research to business", INVESTMENT 1.5, "Creation and strengthening of Innovation Ecosystems" construction of "Territorial R&D leaders", Spoke 6 – Line B - Project 6.1, CUP:

H23C22000370006.
Please refer to Section 9 for further details.

- *True Detective 4.0*
(*Local Unit Scientific Coordinator*)
Scientific Coordinator of the True Detective 4.0 project (PON Project 2014-2020. N.PROG: F/190105/02/X44, CUP: B61B20000290005, COR: 1713400. Resources provided by the decree of the Minister of Economic Development of MARCH 5, 2018 Chapter III - Open Window Procedure - Area: Smart Factory. Grant Decree n. 0001711 of 16/04/2020. Total eligible cost Euro 2,747,347.50. Project Start Date: 01-07-2019 – Duration: 36 months) for Andromeda ESP s.r.l.
Within the project, *directed* and *coordinated* a joint team of *University Researchers* (*University of Calabria*) and *developers* (*Andromeda ESP s.r.l.*).
Please refer to Section 9 for further details.

- *GENESIS*
(*Area Manager*)
Head of the IT area of the project "GENESIS - GEstioNE del rischio SISmico per la valorizzazione turistica dei centri storici del Mezzogiorno", within the National Operational Program (PON) Research and Innovation 2014 – 2020 - Axis 2 - Thematic projects - II.2 Cluster, Call D.D. n. 1735 of 13/07/2017 for the submission of Industrial Research and Experimental Development Projects in the 12 Specialization Areas identified by the PNR 2015-2020, Application ARS01_00883, Specialization Area CULTURAL HERITAGE. CUP: D96G18000160005.
Please refer to Section 9 for further details.

- *INTERCONNECTING*
(*Area Manager*)
Head of the IT area of the project "INTERCONNECTING - Modelli digitali Immersivi per la conservazione sostenibile del patrimonio costruito: valutazione del rischio e strategie proattive", PNRR project on a Cascade Call, funded by the European Social Fund 2014-2020, NextGenerationEU – D.D. 210/2024, Call "Cultural Heritage Active Innovation for Next-Gen Sustainable Society (CHANGES), spoke 7". Total Contribution Obtained: 220,000 €. Partners: ASDEA SRL, POLITECNICO DI BARI, CUP: B53C22004010006.
Please refer to Section 9 for further details.

- *PRECEDE*
(*Scientific Coordinator Third-Party Research Contract*)
Scientific coordinator of a *third-party research contract* related to the framework agreement signed on 18/01/2024 between: i) InGeo (Department of Engineering and Geology) - "G. d'Annunzio" University of Chieti-Pescara, ii) EWay Enterprise Business Solutions s.r.l. and iii) DataRiver s.r.l., within "PREvisioni climatiche ed energetiche a supporto delle Comunità Energetiche con modelli di DEep learning (PRE.C.E.DE.)", PNRR project, program "ECOSISTER - Ecosystem for Sustainable Transition in Emilia-Romagna", ECS00000033 funded by the European Union – "Next Generation EU" on PNRR MUR funds – M4C2 – Investment 1.5, Spoke 2, Topic B, CUP: E93C22001100001.
Duration: 12 months, Contract amount (euro): 45,500.00 + VAT.
Please refer to Section 9 for further details.

- *SOFIA*
  (*Scientific Coordinator Third-Party Research Contract*)
  Scientific coordinator of a *third-party research contract* related to the project "SOFIA" - Cascade Call Program "TECH4YOU - TECHNOLOGIES FOR CLIMATE CHANGE ADAPTATION AND QUALITY OF LIFE IMPROVEMENT", prog. MUR: ECS00000009, CUP: H23C22000370006, funded by the European Union – "Next Generation EU" on PNRR MUR funds – M4C2 – Investment 1.5.

  Please refer to Section 9 for further details.

- *HumanE-AI-Net*
  (*Research Activity*)
  The HumanE-AI-Net project (*https://www.humane-ai.eu/*) aims to develop robust and reliable AI systems capable of '*understanding*' human beings, adapting to complex real-world scenarios and interacting correctly in difficult social contexts.
  Please refer to Section 9 for further details.

- *xFi*
  (*Team Leader*)
  xFi is the home network management software that Comcast Corporation (American multinational leader in telecommunications and entertainment) provides to its customers. It offers sophisticated features for network monitoring and management and for protection against external attacks.
  (https://corporate.comcast.com/company/xfinity/internet/xfi)

- *Telesio*
  (*Team Leader and Developer*)
  The TELESIO Project is aimed at caring for elderly people. Its objective is to monitor the environment in which they live and, when made possible by current privacy protection regulations, their vital parameters (heart rate, blood pressure, etc.) in order to detect potentially dangerous events. To provide these functionalities, TELESIO uses telemetric data streams from a set of IoT sensors belonging to wearable devices (SmartWatch, SmartPhone, etc.) or installed in the home environment (pressure, temperature, humidity, audio, movement sensors, etc.). The data from these telemetric streams are processed with AI algorithms that allow extracting information related to the states and events of the monitored subject and the environment in which they live. In particular, data analysis is performed through *Deep Neural Networks (DNN).*

- *Phoenix*
  (*Database Designer, System Architecture Designer, Developer and Team Leader*)
  Phoenix is a powerful Decision Support System for Public Administration, used for ordinary tax management, assessment activities and territorial control.
  (https://www.eway-solutions.it/prodotti/phoenix/)
  (https://www.eway-solutions.it/prodotti/phoenix-accertamento/)

- *eCoam*
  (*Database Designer, System Architecture Designer, Developer and Team Leader*)
  eCoam is a system for environmental accounting intended for Public Administration.
  (https://www.eway-solutions.it/prodotti/ecoam/)

- *eIMES 3D*
  (*Database Designer*)
  eIMES 3D is a platform that supports physicians and oncology specialists in analyzing DICOM images, facilitating their diagnostic activities.
  (https://www.eway-solutions.it/prodotti/e-imes-3d/)

- *Simpatico 3D*
  (*Database Designer*)
  SIMPATICO (Sistema Informativo Medico PATologIe COmplesse) 3D is a system that supports scientists and physicians by providing a shared virtual environment for image analysis. It is a joint project involving the software house eway Enterprise Business Solutions, the DIMES Department of the University of Calabria and the DMSC Department of the Magna Grecia University of Catanzaro.

- *Squid*
  (*System Architecture Designer, Developer and Team Leader*)
  Squid is a P2P system for integrating and querying distributed data sources. Each node of the network managed by Squid is an autonomous system with its own database managed by a DBMS (ORACLE, MySQL, SQL Server, etc.) or with files containing data (text, XLS, XML, etc.) supporting local applications. Each node can then import data from other network nodes and can export its own. Squid allows integrating local data with maximal subsets of data extracted from other nodes, which do not violate local integrity constraints.
  (http://www.eway-solutions.it/index.php/squid-software)

Has collaborated, performing design and development activities, on the following *funded projects*:

- *From October 2007 to September 2010*: *TOCAI* project, funded by the Ministry of University and Research within the FIRB program (Fund for Basic Research Investments). The project's objective was to develop a set of integrated methodologies and software tools for the analysis, implementation and evaluation of new organizational models for business related to interconnected enterprises.

- *From September 2007 to September 2009*: *ViroLab* project (in collaboration with the University of Amsterdam), funded by the European Community within the 7FP, regarding the implementation of a Decision Support System for the analysis of interactions between drugs and HIV virus - http://virolab. cyfronet.pl/.

- *From November 2011 to May 2014*: TETRis project (Servizi Innovativi Open Source su TETRA), PON Research Call "Smart Cities & Communities", Smart Culture and Tourism. TETRis aims to organize, create, disseminate and monitor innovative Open Source systems and components in the TETRA field oriented to various domains such as emergency management, environmental control, logistics and transport, utilities and services for citizens. The main objective of the project is to introduce elements of strong innovation tending to characterize the so-called Smart Countries and Smart Cities, in which the planning and governance of the territory and its resources in danger and emergency situations are assisted by the set of social sensor networks and technological devices that will be distributed in it.

- *From October 2012 to June 2015*: *Login* project (*LOGistica INtegrata*) whose objective was the creation of a platform for the global and integrated management of goods and information flows as elements of valorization of 'Made in Italy' products.

- *From April 2013 to June 2016*: *InMOTo* project (*Information and Mobility for Tourism*). It is part of the Culture and Tourism project which has the objective of defining and implementing innovative models, processes and tools for the sustainable development of an intelligent territory through the valorization, promotion and commercialization of the tourism offer of its cultural heritage and environmental resources.

Has directed development teams in the following companies:

- XCal s.r.l. (https://www.xcal.eu) and
  Andromeda ESP s.r.l. (https://www.andromedaesp.it/).
  Activities: development of home network management systems for Comcast Corporation (https://corporate.comcast.com/).
  Role: General Manager and CTO.
  Period: from October 2, 2017 to October 1, 2022.

- e way s.r.l. (http://www.eway-solutions.it/).
  Activities: design and development of systems for Public Administration.
  Role: Team Leader and CTO.
  Period: from October 1, 2005 to October 1, 2022.

- Geodrome s.r.l. (http://www.geodrome.it/).
  Activities: design and development of systems for Public Administration.
  Role: Team Leader and CTO.
  Period: from June 1, 2013 to January 31, 2016.

Has also conducted the following activities:

- As an expert in geographic databases, conducted an extensive assessment activity of the *ICI Terreni (year 2006)* tax in the territory of Lamezia Terme.

- Was a founding member of the *DOMINO* association (*http://www.dominoformazione.it/*), accredited as a training body with the Calabria Region, in October 2007. Within this association, from February 2008 to June 2016, held the role of Technical Manager.

9 Organization, Direction and Coordination of National and International Research Groups, or Participation in Them

Is **Scientific Coordinator** (**Principal Investigator**) of the following funded projects:

- *MULTI-TWIN*
  Scientific coordinator of the PNRR project "Intelligenza artificiale a supporto di analisi MULTI-rischio mediante digital-TWIN (MULTI-TWIN)", related to the Public Call for Cascade Tender issued with D.R. n. 1433 of 17/04/2024 within Spoke 5 "Environment & Natural Disasters" Project "National Centre for HPC, Big Data and Quantum Computing", funded under the National Recovery and Resilience Plan, Mission 4 "Education and research" – Component 2 "From research to business" – Investment 1.4, funded by the European Union – NextGenerationEU, Project Code CN00000013, CUP H93C22000450007.
  Duration: 12 months, Total project costs (euro) 773,414.00, Total contribution requested (euro)

773,414.00, Total contribution funded (euro) 773,414.00, Funding approval date: 18/09/2024. The project allowed funding 7 *scholarships* for which Luciano Caroprese is responsible.

Description
The MULTI-TWIN project aims to develop an innovative system for Multi-risk analysis of historic centers and critical structures, combining artificial intelligence technologies, digital twin and real-time structural/territorial monitoring. The integration of these systems will allow addressing cascading natural risks with a new level of precision and proactivity, improving the safety and resilience of critical infrastructures and historic centers. Project activities will include: 1) Installation of Advanced Sensors: Next-generation sensors will be used for continuous monitoring of vibrations, structural displacements, and environmental parameters, collecting critical data on buildings and the urban environment. 2) Quick and Accurate Surveys: Survey of historic centers and critical structures using traditional and advanced tools (e.g. drones, vision-based instruments). 3) Development of Artificial Intelligence models: Implementation and training of new Deep Learning models and/or fine-tuning of existing models that will process data streams sent by sensors and extract meaningful information for Multi-risk analysis. The information returned by these models will allow timely detection of dangerous situations and/or feed Digital Twins that make predictions of the structural behavior of buildings. 4) Development of Digital Twins: Creation of detailed digital models for real-time simulation and analysis of urban centers and buildings, enabling prediction of structural vulnerability. 5) Development of a web-based application that allows the operator to: a) upload/view/modify alphanumeric/cartographic data entered into the system and use them, together with outputs from Artificial Intelligence models and Digital Twins, to conduct hazard and vulnerability assessments of historic centers (territorial level) and critical structures (building level). b) execute algorithms for Multi-risk analysis (seismic risk and hydrogeological risk) and visualize their outputs on thematic maps and reports. 6) Multi-risk Planning: Development of intervention strategies based on data obtained from the system, for more effective civil protection planning at urban and territorial scale. The project will be implemented in the pilot site of Popoli (PE) with hydro-geomorphological characteristics useful for testing the effectiveness of installed technologies in complex territorial contexts. Expected results include reduction of response times in case of emergency, improvement of public safety and protection of the architectural and historical heritage of the urban area considered.

Proposer
InGeo Department, "G. d'Annunzio" University of Chieti-Pescara.

- *AI4MOOC*
  Scientific coordinator of the PNRR project "Artificial Intelligence for Massive Open Online Courses (AI4MOOC)", Program Tech4You (code ECS 00000009), MISSION 4 COMPONENT 2, "From research to business", INVESTMENT 1.5, "Creation and strengthening of Innovation Ecosystems" construction of "Territorial R&D leaders", Spoke 6 – Line B - Project 6.1, CUP: H23C22000370006.
  Duration: 15 months, Total project costs (euro) 127,010.00, Total contribution requested (euro) 95,000.00, Total contribution funded (euro) 95,000.00, Funding approval date: 26/07/2024.

  Description
  The "AI4MOOC" project aims to revolutionize the approach to online education through the

development of an intuitive system based on Large Language Models (LLM), which allows users, regardless of their level of technical competence, to create personalized courses Massive Open Online Courses (MOOC). Through a wizard-type guided interface, the system facilitates course composition, guiding the user through a series of simple questions and using the answers to invoke the APIs of the most suitable LLMs, which generate tailored educational content. This platform will integrate different LLMs to exploit their peculiarities, such as Perplexity for the integration of carefully selected web content. With a focus on ease of use and accessibility, AI4MOOC aims to democratize the creation of high-quality educational content, making personalized education more accessible and influential, benefiting students, professionals and entrepreneurs in the startup and research field.

Partners
i) InGeo Department, "G. d'Annunzio" University of Chieti-Pescara,
ii) E Way Enterprise Business Solutions s.r.l.,
iii) Revelis s.r.l.

Was **Local Unit Scientific Coordinator** of the following funded project:

- *True Detective 4.0*
  Scientific Coordinator of the True Detective 4.0 project (PON Project 2014-2020. N.PROG: F/190105/02/X44, CUP: B61B20000290005, COR: 1713400. Resources provided by the decree of the Minister of Economic Development of MARCH 5, 2018 Chapter III - Open Window Procedure - Area: Smart Factory. Grant Decree n. 0001711 of 16/04/2020. Total eligible cost Euro 2,747,347.50. Project Start Date: 01-07-2019 – Duration: 36 months) for Andromeda ESP s.r.l. Within the project *directed* and *coordinated* a joint team of *University Researchers* (*University of Calabria*) and *developers* (*Andromeda ESP s.r.l.*).

  Description
  True Detective 4.0 is a system for managing Physical Security and Compliance with Security Policies in the business environment. The system is a valuable tool to support World Class Manufacturing (WCM), a structured and integrated production system that includes all business processes, from safety to environment, from maintenance to logistics and quality. In particular, the platform contributes to the first pillar of WCM: safety. The system includes a set of sensors installed on wearable devices and in the work environment that send telemetric data streams related to the main vital parameters of the monitored subject (body temperature, heart rate, etc.) and a set of physical quantities (e.g. temperature, pressure, brightness, humidity, movement, audio, video, etc.). Raw data are processed by a module that, through sensor data fusion techniques, extracts information related to events and states concerning subjects and the workplace. This information is given meaning through an expert system based on rules that models the safety policies defined by the company or by the legislator. The system includes a module based on machine learning techniques for learning the dynamics of the production process. This module allows detecting anomalies in the workplace for which modeling through rules is complex or not feasible.

Is **Scientific Coordinator** of the following **Third-Party Research Contracts**:

- *PRECEDE*

Is *Scientific Coordinator* of a *Third-Party Research Contract* related to the framework agreement signed on 18/01/2024 between:

- InGeo (Department of Engineering and Geology) - "G. d'Annunzio" University of Chieti-Pescara,
- EWay Enterprise Business Solutions s.r.l. and
- DataRiver s.r.l.,

within "PREvisioni climatiche ed energetiche a supporto delle Comunità Energetiche con modelli di DEep learning (PRE.C.E.DE.)", PNRR project, program "ECOSISTER - Ecosystem for Sustainable Transition in Emilia-Romagna", ECS00000033 funded by the European Union – "Next Generation EU" on PNRR MUR funds – M4C2 – Investment 1.5, Spoke 2, Topic B, CUP: E93C22001100001, Total project costs (euro) 649,975.00, Total contribution requested (euro) 481,426.75, Total contribution funded (euro) 481,426.75.

Description
The project proposes the development of a system to support photovoltaic energy distribution and serving Energy Communities, capable of managing and integrating the large amount of necessary data and offering, based on these, innovative services for calculating climate and energy forecasts, for more reliable production estimates, and from this a more efficient planning of energy storage and distribution. The system will propose a platform for the management and virtual integration of different data (real, from Regional Climate Models) and will have ML/DL models that provide more accurate forecasts of values related to the main climate variables. It will also exploit ML techniques for optimizing energy flows that will take into account, among other factors, energy consumption profiles, self-production forecasts, and the characteristics of existing storage systems. In accordance with the Europe 2020 strategy, the European Green Deal and the objectives of the PNRR, the project contributes to the implementation of key policies and objectives both at European and national and regional level. At the regional level, in particular, the project integrates with the strategies and specific objectives of Emilia Romagna, providing advanced solutions to optimize the use of energy resources and promote sustainable practices.

Partners
ii) E Way Enterprise Business Solutions s.r.l. (lead partner),
ii) DataRiver s.r.l.

Research organizations (RO)
i) InGeo (Department of Engineering and Geology) - "G. d'Annunzio" University of Chieti-Pescara,
ii) DIMES (Department of Computer, Modeling, Electronics and Systems Engineering) - University of Calabria.

Description of the research contract
The *third-party research contract* is stipulated between the partner company DataRiver s.r.l. and the RO InGeo (Department of Engineering and Geology) - "G. d'Annunzio" University of Chieti-Pescara.

Subject matter
RT2.2.2 (related to activity WP2.A2) Recurrent Neural Models for climate forecasts: state of the art, design and development of a demonstrator.
RT2.3.2 (related to activity WP2.A3) Refinement of photovoltaic energy production estimation using Machine Learning techniques: state of the art, design and implementation of a demonstrator.

Duration: 12 months,
Contract amount (euro): 45,500.00 + VAT.

- *SOFIA*
  Is *Scientific Coordinator* of a *Third-Party Research Contract* with a duration of 10 months, amounting to 3,000.00 euros + VAT. The contract is stipulated between the company XCal s.r.l. and InGeo (Department of Engineering and Geology) - "G. d'Annunzio" University of Chieti-Pescara. The activities to be carried out are as follows:

  – Technical report on Deep Learning models for video stream analysis
  – Support for the implementation/fine-tuning of a Deep Learning model for video stream analysis

  The activities will be carried out within the PNRR project Deep Learning models aimed at video stream analysis within the project "SOFIA" - Cascade Call Program "TECH4YOU - TECHNOLOGIES FOR CLIMATE CHANGE ADAPTATION AND QUALITY OF LIFE IMPROVEMENT", prog. MUR: ECS00000009, CUP: H23C22000370006, funded by the European Union – "Next Generation EU" on PNRR MUR funds – M4C2 – Investment 1.5.

  Description
  The project involves the development of an innovative security system for the university campus, based on a multi-layer architecture that integrates advanced sensors and artificial intelligence (AI). The first layer, which includes surveillance cameras, any mobile devices used by guards through a dedicated app, and any other available sensors, collects continuous data on conditions and events on campus. The second layer consists of a set of AI models that process data streams from the first layer. We call the set of these models 'first-level AI'. Using machine learning and deep learning techniques, the first-level AI extracts meaningful information from the streams, identifying states and events of interest for the Campus monitoring process. The third layer provides a connector with a probabilistic model based on a Bayesian network with which it will be possible to evaluate the probability of specific events such as thefts and accidents (damages or injuries). In particular, by valuing some stochastic variables with the information extracted from the first-level AI, the network will return probabilistic evaluations on risk scenarios.

  Proposer
  XCal s.r.l.

Is **Area Manager** of the following funded projects:

- *GENESIS*
  Is *head of the IT area* of the project "GENESIS - GEstioNE del rischio SISmico per la valorizzazione turistica dei centri storici del Mezzogiorno", within the National Operational Program

(PON) Research and Innovation 2014 – 2020 - Axis 2 - Thematic projects - II.2 Cluster, Call D.D. n. 1735 of 13/07/2017 for the submission of Industrial Research and Experimental Development Projects in the 12 Specialization Areas identified by the PNR 2015-2020, Application ARS01_00883, Specialization Area CULTURAL HERITAGE. CUP: D96G18000160005.
LEAD subject: Ud'A - "G. d'Annunzio" University of Chieti - Pescara, Scientific Coordinator: Prof. Enrico SPACONE, Start of activities: 01/01/2023, Project duration: 30 months, Grant decree: D.D. 0001917 of 28/07/2021, Deed of obligation signature: 07/12/2022, Total project cost: Euro 8,873,812 of which Euro 4,338,926.00 PON MIUR grant, Total Ud'A cost: Euro 840,000.00 of which Euro 400,500.00 PON MIUR grant.

Description
The need to reduce seismic risk of the immense national cultural heritage was dramatically highlighted by recent seismic events that caused the destruction of entire historic centers, testimony to the history and traditions of our Country, with obvious repercussions on the economy and tourism, which constitutes one of the major development opportunities for Southern Italy. The proposal aims to offer valid support for the protection and safe and aware use of cultural heritage through knowledge of their history and characteristics, deepening and improving the methods of use, defining innovative forms of management. The project intends to develop a computer platform, "GENESIS", capable of collecting information on heritage of historical-cultural interest, processing it at increasing scales of accuracy: from the territorial/urban scale (historic center), to that of a single building, allowing the execution of the following analyses: at territorial scale, the simulation of damage scenarios useful for managing emergency situations; at urban scale, the planning of seismic risk reduction interventions; at the scale of a single building, the development of structural behavior models for the evaluation of static safety and seismic vulnerability as well as interventions that may be necessary based on the previous analysis. The development of numerous case studies referring to characteristic historic centers of Southern Regions (demonstrators) is planned, with full-scale experimental tests, and the development of innovative products and new methodologies for the protection, safeguarding and conservation of historic and monumental buildings. This will allow providing, at a technical level, indications on intervention strategies through cost-benefit analyses that combine the need for seismic risk reduction and conservation with tourism valorization and, at a tourism level, multi-level access to information (guided tours, thematic insights, direct access to sources etc). This will allow multiplying tourism and cultural attractiveness and competitiveness according to the objectives indicated by the Strategic Tourism Plan 2017-2022 of MIBACT, promoting new modes of use based on the renewal and expansion of the offer and on the valorization of new destinations and new products.

- *INTERCONNECTING*
Is *head of the IT area* of the project "INTERCONNECTING - Modelli digitali Immersivi per la conservazione sostenibile del patrimonio costruito: valutazione del rischio e strategie proattive", PNRR project on a Cascade Call, funded by the European Social Fund 2014-2020, NextGenerationEU – D.D. 210/2024, Call "Cultural Heritage Active Innovation for Next-Gen Sustainable Society (CHANGES), spoke 7". Total Contribution Obtained: 220,000 €. Partners: ASDEA SRL, POLITECNICO DI BARI, CUP: B53C22004010006.

Description

The project aims to develop an integrated platform to manage and analyze heterogeneous data from multisensor systems and historical-critical research. Through Digital Twin models, INTERCONNECTING allows identifying vulnerable areas and predicting future trends with multi-risk analysis. Integrating virtual reality and multi-criteria decision methods, the platform allows identifying optimal intervention strategies with innovative and sustainable materials. Within the INTERCONNECTING project, as head of the IT area, participated in defining the technical and functional specifications of the system modules and is conducting an intense coordination activity between UniCh and industrial partners.

Is **Scientific Coordinator** of the following **Framework Agreements**:

- Is *scientific coordinator* of a five-year *framework agreement* signed on 15/07/2023 between:
  - Department of Engineering and Geology of "G. d'Annunzio" University of Chieti-Pescara (InGeo),
  - Department of Computer, Modeling, Electronics and Systems Engineering of the University of Calabria (DIMES).

  The subjects of collaboration are:
  - research and consulting activities,
  - teaching and training activities.

  The collaboration activity has allowed Luciano Caroprese to hold the role of co-supervisor of a PhD student from DIMES, XXXIX Cycle. The collaboration activity has led to the publication of numerous scientific articles and to the organization of:
  - Two editions (2023, 2024) of the International Workshop *AIPREF (AI-Powered Renewable Energy Forecasting: Techniques and Challenges)* at the *IEEE BigData (IEEE International Conference on Big Data, GGS rating: B)*,
  - Two editions (2023, 2024) of the Special Session *ML4EO (Machine Learning for Earth Observation)* at the *IEEE ICMLA (IEEE International Conference on Machine Learning and Applications)*,
  - Two editions (2023, 2024) of the International Workshop *AIBH (Artificial Intelligence Techniques for BioMedicine and HealthCare)* at the *IEEE BIBM (IEEE International Conference on Bioinformatics and Biomedicine).*
- Is *scientific coordinator* of a three-year *framework agreement* signed on 18/01/2024 between:
  - Department of Engineering and Geology of "G. d'Annunzio" University of Chieti-Pescara (InGeo),
  - EWay Enterprise Business Solutions s.r.l.,
  - DataRiver s.r.l.

  Subject of collaboration:
  - Design of models for climate forecasts,

  - Design and development of modules for energy production forecasting,
  - Dissemination of results, through scientific works.

- Is *scientific coordinator* of a three-year *framework agreement* signed on 11/04/2024 between:

  - Department of Engineering and Geology of "G. d'Annunzio" University of Chieti-Pescara (InGeo),
  - EWay Enterprise Business Solutions s.r.l.,
  - Revelis s.r.l.

  Subject of collaboration:

  - Study of the state of the art related to LLM models applied to digital education,
  - Definition of functional specifications of the AI4MOOC system.

Is **member of an international research group**, which involves *ICAR CNR*, *University of Porto* and *University of Leiden*, which is participating in the following European project:

- *HumanE-AI-Net*
  (*https://www.humane-ai.eu/*)
  The HumanE-AI-Net project, funded by the EU, brings together leading European research centers, universities and industrial companies in a network of centers of excellence. Some important international laboratories dealing with artificial intelligence (AI) will collaborate with key stakeholders in areas such as human-computer interaction and cognitive, social and complexity sciences. The project hopes to take researchers out of their narrow field of study, connecting them with people who analyze AI on a much larger scale. The challenge consists in developing robust and reliable AI systems, capable of "*understanding*" human beings, adapting to complex real-world scenarios and interacting correctly in difficult social contexts. The HumanE-AI-Net project will lay the foundations for the creation of the principles of a new science that will make AI more focused on European values and closer to European citizens.
  The first results of the activity performed are reported in the scientific article [68].

Is or was **member of research groups** participating or that have participated in the following funded projects:

- *Since November 2023.* Is member of a national research group dealing with the development of the project *"SOUND-SIRC"*, DD 1409/2022 of 14/09/2022- PRIN 2022 PNRR Call Title The Sound in the digital era: Spaces, Identity, Rights and Culture, Code P20228YK2L, CUP D53D23020380001.

  The Project aims to characterize, in order to protect, conserve and promote, intangible cultural heritage in closed spaces and open spaces. Closed spaces are identified as places of worship (e.g. churches, cathedrals, temples) and theaters. For these spaces, experimental measurements and numerical modeling will be carried out for the analysis, understanding and collection of the acoustic characteristics that define the asset. For open spaces, binaural measurement campaigns and subjective perception analysis through questionnaire administration will be carried out. The results of tests and measurements will be processed with the aid of Machine/Deep Learning techniques.

Within the Sound-SIRC project, is dealing with the development of Deep Learning models for detecting changes in the sound characteristics that characterize the monitored environments.

- *From December 2022 to December 2023.* Was member of a national research group that dealt with the development of the PON project *"ENERGIDRICA: efficienza energetica nella gestione delle reti idriche"*, CUP B53C22004010006.

  The objective of the Energidrica project is the development of a decision support system for energy efficiency of water supply and distribution networks, generating process innovations and integration with sustainable energy sources in three complementary decision areas: i) supply schemes for urban centers from multiple sources, ii) pumping management in transmission and distribution networks, iii) integration with sustainable energy sources in a self-consumption logic.

  Within the Energidrica project dealt with the development of Deep Learning models for forecasting climate and energy variables.

- *From October 2007 to September 2010.* Was member of a national research group that dealt with the development of the project *"TOCAI"*, funded by the Ministry of University and Research within the FIRB program (Fund for Basic Research Investments). The project's objective was to develop a set of integrated methodologies and software tools for the analysis, implementation and evaluation of new organizational models for business related to interconnected enterprises.

- *From September 2007 to September 2009.* Was member of a national research group that dealt with the development of the project *"ViroLab"* (in collaboration with the University of Amsterdam), funded by the European Community within the 7FP, regarding the implementation of a Decision Support System for the analysis of interactions between drugs and HIV virus (*http://virolab. cyfronet.pl/*).

- *From November 2011 to May 2014.* Was member of a national research group that dealt with the development of the project *"TETRis (Servizi Innovativi Open Source su TETRA)"*, PON Research Call "Smart Cities & Communities", Smart Culture and Tourism. TETRis aims to organize, create, disseminate and monitor innovative Open Source systems and components in the TETRA field oriented to various domains such as emergency management, environmental control, logistics and transport, utilities and services for citizens. The main objective of the project is to introduce elements of strong innovation tending to characterize the so-called Smart Countries and Smart Cities, in which the planning and governance of the territory and its resources in danger and emergency situations are assisted by the set of social sensor networks and technological devices that will be distributed in it.

- *From October 2012 to June 2015.* Was member of a national research group that dealt with the development of the project *"Login (LOGistica INtegrata)"* whose objective was the creation of a platform for the global and integrated management of goods and information flows as elements of valorization of 'Made in Italy' products.

- *From April 2013 to June 2016.* Was member of a national research group that dealt with the development of the project *"InMOTo (Information and Mobility for Tourism)"*. It is part of the Culture and Tourism project which has the objective of defining and implementing innovative models, processes and tools for the sustainable development of an intelligent territory through the valorization, promotion and commercialization of the tourism offer of its cultural heritage and environmental resources.

10 Speaker at National and International Conferences

- *Invited Keynote Speaker.*
  Workshop *AI&BDvsPandemics* (*Artificial Intellingence and Big Data vs Pandemics*) 2021 at *IEEE BIBM* (*IEEE International Conference on Bioinformatics and Bio-medicine*) 2021, December 9-12, 2021.
  Title: *"Graph Neural Networks in Healthcare"*
  Date: December 9, 2021

- Presented the following scientific works at *national and international conferences*. A selection of the presentations is reported below.

  - L. Caroprese, S. Greco, E. Zumpano, A Logic Programming Approach to Querying and Integrating P2P Deductive Databases. FLAIRS 2006, pp. 31-36.
  - L. Caroprese, S. Greco, C. Sirangelo, E. Zumpano, Declarative Semantics of Production Rules for Integrity Maintenance. ICLP 2006, pp. 26-40, ISBN 3-540-36635-0.
  - L. Caroprese, M. Truszczynski, Declarative Semantics for Revision Programming and Connections to Active Integrity Constraints. Jelia 2008, pp. 100-112, ISBN 978-3-540-87802-5.
  - L. Caroprese, M. Truszczynski, Declarative Semantics for Active Integrity Constraints. ICLP 2008, pp. 269-283, ISBN 978-3-540-89981-5.
  - L. Caroprese, B. Ó Nualláin, P.M.A. Sloot, E. Zumpano, A Logical Framework for Detecting Anomalies in Drug Resistance Algorithms. IDEAS 2009, pp. 23-30, ISBN 978-1-60558-402-7.
  - L. Caroprese, E. Zumpano, Aggregates and Priorities in P2P Data Management Systems. IDEAS 2011, pp. 1-7, ISBN 978-1-4503-0627-0
  - L. Caroprese, E. Zumpano, Handling Preferences in P2P Systems. FoIKS 2012, pp. 20191-106, ISBN 978-3-642-28471-7.
  - L. Caroprese, E. Zumpano, Restoring Consistency in P2P Deductive Databases. SUM 2012, pp. 168-179, ISBN 978-3-642-33361-3
  - L. Caroprese, I. Trubitsyna, M. Truszczynski, E. Zumpano, A Measure of Arbitrariness in Abductive Explanations. ICLP 2014.
  - L. Caroprese, E. Zumpano, Dealing with Incompleteness and Inconsistency in P2P Deductive Databases. IDEAS 2014, pp. 124-131, ISBN 978-1-4503-2627-8.
  - L. Caroprese, E. Zumpano, A Logic Based Approach for Restoring Consistency in P2P Deductive Databases. DEXA 2015, pp. 3-12, ISBN 978-3-319-22851-8.
  - L. Caroprese, E. Zumpano, Generalized Maximal Consistent Answers in P2P Deductive Databases. DEXA 2016, pp. 368-376, ISBN 978-3-319-44405-5.
  - L. Caroprese, E. Zumpano, A Declarative Semantics for P2P Systems. CD-MAKE 2017.
  - L. Caroprese, E. Zumpano, P2P Deductive Databases: A System Prototype. IIWAS 2017.
  - A. Berlino, L. Caroprese, A. La Marca, E. Vocaturo and E. Zumpano, Augmented Reality for the Enhancement of Archaeological Heritage: a Calabrian Experience. VIPERC 2019.
  - E. Vocaturo, E. Zumpano, L. Caroprese, S. M. Pagliuso and Divina Lappano, Educational Games for Cultural Heritage. VIPERC 2019.

- A. Berlino, L. Caroprese, E. Vocaturo and E. Zumpano, A Mobile Application for the Enhancement of POIs in Calabria. VIPERC 2020.
- A. Berlino, L. Caroprese, G. Mirabelli and E. Zumpano, Teiresias: a Tool for Automatic Greek Handwriting Translation. VIPERC 2020.
- E. Coppolillo, M. Minici, E. Ritacco, L. Caroprese, F. Pisani, G. Manco, Balanced Quality Score (BQS): Measuring Popularity Debiasing in Recommendation.
  European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML-PKDD) 2024, Nectar Track

11 National and International Awards and Recognitions for Research Activity

- **Best Student Paper Award**.
  L. Caroprese, S. Greco, C. Sirangelo, E. Zumpano, *"Declarative Semantics of Production Rules for Integrity Maintenance"*.
  ICLP 2006, Seattle, WA, USA, August 17-20, pp. 26-40, ISBN 3-540-36635-0.
  (https://www.cs.nmsu.edu/ALP/the-association-for-logic-programming/alp-awards/)

12 Other Scientific Activities

- **Editorial Board Member**
  - Journal of Intelligent Information Systems (JIIS)
    Integrating Artificial Intelligence and Database Technologies,
    Springer.
    Electronic ISSN: 1573-7675, Print ISSN: 0925-9902.
    From March 2, 2022 to November 14, 2023
  - Scalable Computing: Practice and Experience (SCPE)
    Universitatea de Vest din Timisoara.
    ISSN: 1895-1767
    From May 3, 2022 to present
- **Guest Editor**
  - Special Issue "Mathematical Theories in the Era of Big Data (DIC)."
    (http://www.hindawi.com/journals/MPE/si/630903/cfp/)
- **Editorial Direction**
  - B. C. Desai, S. Flesca, E. Zumpano, E. Masciari, L. Caroprese, Proceedings of the 22nd International Database Engineering and Applications Symposium, IDEAS 2018, Villa San Giovanni, Italy, June 18-20, 2018. ACM 2018, doi: 10.1145/3216122
  - E. Zumpano, L. Caroprese, P. Veltri, A. Calì and F. Radulescu, Mathematical Theories in the Era of Big Data, doi: 10.1145/3216122 Mathematical Problems in Engineering Volume 2019, doi: 10.1155/2019/9231923

- **Guest Researcher and Lecturer**
  Katholieke Universiteit Leuven.
  Lecture in the Databases course: *"From Relational to NoSQL Databases"*
  Date: *May 24, 2018*

- **Program Chair**
  - *IDEAS 2018* (International Database Engineering & Applications Symposium 2018), June 18-20, 2018, Villa San Giovanni, Italy.
  - Workshop *AIBH 2018* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2018) at *IEEE BIBM 2018* (IEEE International Conference on Bioinformatics and Biomedicine 2018), December 3-6, 2018, Madrid.
  - Workshop *AIBH 2019* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2019) at *IEEE BIBM 2019* (IEEE International Conference on Bioinformatics and Biomedicine 2019), November 18-21, 2019, San Diego, CA, USA.
  - Workshop *AIBH 2020* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2020) at *IEEE BIBM 2020* (IEEE International Conference on Bioinformatics and Biomedicine 2020), December 16-19, 2020, Seoul, Korea.
  - Workshop *AIBH 2021* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2021) at *IEEE BIBM 2021* (IEEE International Conference on Bioinformatics and Biomedicine 2021), December 9-12, 2021.
  - Workshop *AIBH 2022* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2022) at *IEEE BIBM 2022* (IEEE International Conference on Bioinformatics and Biomedicine 2022), December 6-8, 2022.
  - Workshop *AIBH 2023* (Artificial Intelligence Techniques for BioMedicine and HealthCare 2023) at *IEEE BIBM 2023* (IEEE International Conference on Bioinformatics and Biomedicine 2023), December 5-8, 2023.
  - *VIPERC 2023* (Visual Pattern Extraction and Recognition for Cultural Heritage Understanding 2023), September 25-26, 2023, Zadar, Croatia.
  - Workshop *AIPREF 2023* (AI-Powered Renewable Energy Forecasting: Techniques and Challenges 2023) at *IEEE BigData 2023* (IEEE International Conference on Big Data 2023), December 15-18, 2023.
  - Special Session *ML4EO 2023* (Machine Learning for Earth Observation 2023) at *IEEE ICMLA 2023* (IEEE International Conference on Machine Learning and Applications 2023), December 15-17, 2023.
  - Workshop *BDCAT4WM* (Big Data Computing, Applications and Technologies for Waste Management) at the *BDCAT 2023* Conference, December 4-7, 2023.

- **Steering Committee Member**
  - Workshop *AIBH (Artificial Intelligence Techniques for BioMedicine and HealthCare)* at *IEEE BIBM* (*IEEE International Conference on Bioinformatics and Biomedicine*) (*Since 2019*).
  - Workshop *AI&BDvsPandemics (Artificial Intelligence &Big Data versus Pandemics)* at *IEEE BIBM* (*IEEE International Conference on Bioinformatics and Biomedicine*) (*Since 2020*).

  - Conference *Pervasive knowledge and collective intelligence on Web and Social Media* (*Since 2022*).

- **Industry Session Co-Chair**
  ISMIS 2022 (26th International Symposium on Methodologies for Intelligent Systems), October 3-5, 2022

- **Program Committee Member**
  - *AAAI Conference on Artificial Intelligence* (AAAI) 2018, 2022, 2024, 2025.
  - *European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases* (ECML/PKDD) 2025.
  - *International Joint Conference on Artificial Intelligence* (IJCAI) 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2025.
  - *International Database Engineering & Applications Symposium* (IDEAS) 2019.
  - *International Workshop on Algorithms, Tools and new Frontiers on the use of Networks in Biology and Clinical Science* (BioNet) 2017.

- **Reviewer**
  Collaborated in the review activities of articles proposed for publication at various national and international conferences and journals, including:
  - Artificial Intelligence (AI)
  - Journal of Intelligent Information Systems (JIIS)
  - Scalable Computing: Practice and Experience (SCPE)
  - Knowledge and Information Systems (KAIS)
  - International Joint Conference on Artificial Intelligence (IJCAI)
  - Logic Programming and Automated Reasoning (LPAR)
  - International Conference on Enterprise Information Systems (ICEIS)
  - Conference of Information and Knowledge Management Systems (CIKM)
  - International Conference on Big Data Analytics and Knowledge Discovery (DAWAK)
  - International Database Engineering and Applications Symposium (IDEAS)
  - International Workshop on Algorithms, Tools and new Frontiers on the use of Networks in Biology and Clinical Science (BioNet)
  - Sistemi Evoluti per Basi di Dati (SEBD)

13 Management, Organizational and Service Activities

- *Since February 2024.*
  VQR Representative of the InGeo Department at the University "G. d'Annunzio" of Chieti-Pescara.

- *Since December 2023.*
  Member of the Department Board of the InGeo Department at the University "G. d'Annunzio" of Chieti-Pescara.

- *Since November 2023.*
  IRIS Representative of the InGeo Department at the University "G. d'Annunzio" of Chieti-Pescara.

- *Since November 2023.*
  Member of the Committee for Computing Infrastructures for Research (CICR) at the University "G. d'Annunzio" of Chieti-Pescara

- *Academic Year 2023/2024.*
  Member of the Teaching Commission of the Bachelor's Degree in Construction Sciences (L23) at the University "G. d'Annunzio" of Chieti-Pescara.

14 Other Institutional Positions

- *Academic Year 2025/2026*
  Member of the Faculty Board of the Ph.D. Program
  Artificial Intelligence (National Ph.D. Program), Campus Bio-Medico University of Rome, cycle XLI.
- *Academic Years 2023/2024, 2024/2025, 2025/2026*
  Member of the Faculty Board of the Ph.D. Program
  Information and Communication Technologies, University of Calabria, cycles XXXIX, XL and XLI.
- *Academic Years 2023/2024, 2024/2025*
  Member of the Faculty Board of the Ph.D. Program
  Sustainable Blue Economy and One Health, Leonardo da Vinci Telematic University, cycles XXXIX and XL.

- *September 2023.*
  Member of the Examination Board for admission to the Ph.D. Program
  Sustainable Blue Economy and One Health, Leonardo da Vinci Telematic University, cycle XXXIX.

15 Technical skills

A list of his main technical skills, certified by the role he held in the companies *Comcast Corporation*, *XCal s.r.l.*, *Andromeda ESP s.r.l.*, *e way s.r.l.* and *Geodrome s.r.l.*, is reported below.

- *AI Libraries and Frameworks*: TensorFlow, Keras, Pytorch;

- *Programming Languages*: Java, JavaScript, C, C++, C#, Python, Prolog, Datalog;

- *Database Management Systems*: MySQL (and its Spatial Extensions), PostgreSQL (and PostGIS), SQL Server, Oracle, Cassandra, MongoDB;

- *Development Environments*: Eclipse, NetBeans, IntelliJ, JBuilder, PyCharm, Google Colab;

- *GIS*: Quantum GIS;

- *Other*: Android, J2EE, JBoss, Tomcat, Hibernate, PHP, HTML5, XML.

16 Publications

Publications in International Journals

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