

**PhD in Information and Communication Technologies
University of L'Aquila**

REPORT ON THE ACTIVITIES OF THE CURRENT YEAR

LAST NAME	Asad
NAME	Muhammad
CURRICULUM	Emerging computational models, software architectures, and intelligent systems
DOCTORAL CYCLE	XXXVII

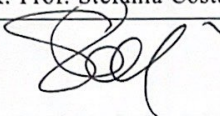
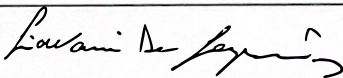

RESEARCH ACTIVITY REPORT	
Research area	Artificial Intelligence, Multi-agent systems, Automated Reasoning and Machine Learning
Description of research activities	<p><u>Phase I(Before coming):</u> In the start I took a Coursera Course named "Tools for Data Science by IBM" as this course is about learning about new tools (python, R, Jupyter notebook, IBM Watson studio etc) which will be useful for me in research. Besides, I read few of research papers related to damage detection in railway bridges, anomaly analysis in railway tracks etc.</p> <p><u>Phase II(After coming to L'Aquila):</u> During the Phase II of my first year, I started my research activities with literature review. I was provided with the initial documentation of the COM-NET Project but it was in Italian language. These documents were provided to me through passive meetings with the project teams. Main activities I performed after getting the initial data were;</p> <ul style="list-style-type: none"> • Translating the provided documents & presentations from Italian to English • Studying the project details • Studying the provided FEM Model • Translating the Matlab code to Python code data to understand the data • Performing initial simulations <p>As the research project is about Anomaly detection from the ambient data received through the accelerometer sensors that have been installed at different location on bridges. I studied the architecture of Finite Element Model and Perception Layer of the COM-NET System. I proposed the architecture of Reasoning Layer of the system. Reasoning Layer takes the data input from the Perception Layer and simulation results from FEM.</p> <p>Furthermore, I studied how FEM & Perception Layer produced ambient data performs on FFT simulation. On the basis of this I am working on design and analysis of Reasoning Layer model which will be based on Fuzzy Rules and Machine Learning algorithms, to generate Damage alerts, Level of damage caused and also the location of damage caused to the bridge. Later, we use results from Perception layer and Reasoning Layer for analysis. In next year we extend the study to analyze Fuzzy Logic Rule & Machine Learning models with the Residual and Correlation index data.</p>

	<p>In addition to system study and modeling, literature review activity is also carried out side by side. Main purpose of it was to know about the available state of the art systems, their dataset, sensor utilization in the project and methodologies used for anomaly detection, damage identification, localization and finally identification.</p> <p><u>Phase III:</u> After the start of 2nd year, I started working on the implementation of the project modules. I started with feature generation from the accelerometer sensor data obtained from the Steel Bridge located at San Saproloco, Città de Castello Italy. Time domain features are extracted and then an RBF & GELU based Neural Network model is developed to check anomalies and monitor structural health using different Bridge Scenarios and Damage Intensities. Based on this research two short papers are also published in ISAmI'23 and AlxIA'23. Another DNN based SHM paper is almost ready to be submitted in a week or so. In parallel, the frequency domain-based paper is in the working phase and is expected to be submitted for ECAI'24 conference.</p> <p>Additionally, I am also working on a Golden Ratio based algorithm for geometric solutions. Its 1-,2-, and 3-D structure algorithm is designed, and I am hoping to extend it to 4th to 'N' dimension mathematically.</p> <p>Beside these research activities, I have attended PhD course 'Ethics of AI', a summer school EASSS'23, ISR Lab and Ontologies for Data Representation advanced level courses, Informing digital twins via remote sensing seminar, SHM related webinar 'ICE Y&H Knowledge Sharing Temporary & permanent steel bridges' and few online Courera courses namely, 'Tools for Data Science', 'Automated Reasoning: satisfiability', 'Data Science Methodology', and 'Engineering of Structures: Tension'. In addition, I am also learning OpenSees software and CURA SLICER software for FEM design and modeling respectively.</p>
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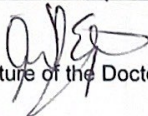
ADVANCED COURSES					
Course	Type	Duration/Period	CFU	Ph.D. Year	Skills
Artificial Intelligence	Master's degree course	48h/ Fall 2022	6	1	This course gave insight about agent, agent-oriented paradigm, and agent architectures in addition to Communication between Agents using Agent-oriented logic languages. This course also covers Representation of knowledge and forms of reasoning in agents, Actions and planning, Use of uncertain knowledge, Coordination models in multi-agent systems, Concrete Architectures and Applications
Automated Reasoning	Master's degree course	48h/ Fall 2022	6	1	In this course I have studied the background of the need of automated reasoning. Further I was able to learn about Constraint Programming, CP-nets, Answer Set Programming (ASP), Extensions to ASP and Action Languages.
Ethics of AI	PhD Course	12+6h/ Spring 2023	3	2	This course covered some ethical issues in design and use of AI and ICT systems. An overview of ethical issues, moral challenges in AI, HCI relationship, control of information between human & AI and discussion about existing approaches for implementing Ethics into AI Agents was discussed.

Intelligent Systems and Robotics Lab	Master's Course	Fall 2023	6	2	This course is related to Robotics lab using mindstrom.
Ontologies for Data Representation	Master's Course	Fall 2023	6	2	In this course I learned about developing Ontologies; (will be using it for designing Ontology for SHM of steel bridges)
European Agent Systems (EASSS) 2023	Summer School	36h/Spring 2023	5	1	It was my first experience attending a Doctoral Summer School. I had learned basics about Agents for autonomous systems
ISAmI 2023	Conference	Spring 2023	3	1	In this conference I presented my 1 st paper during PhD, related to bridge health monitoring. It was a co-located event of PAAMS'23 with many interesting sessions from different domains.
AIXIA 2023	Conference	Fall 2023	3	2	In this conference I presented my second paper. I also attended several other sessions and talks especially related to machine learning and health monitoring and some prominent keynote talks especially by Stuart J. Russell
Informing digital twins via remote sensing	Seminar By Dr David A. Lattanzi	17/03/2023	0.1	1	Learned about digital twins of two historic towers (Garisenda and degli Asinelli) in Balogna and the process by which Dr David is getting the digital data of these towers. He also explained the future direction of using machine learning algorithms that can be used to study about the disaster management of smart cities in context to these Two Towers.
Tools For Data Science	Coursera Course IBM (Online)	18h /March 2022	3	1	In this online Coursera course, I got an overview of the programming languages commonly used, including Python, R, Scala, and SQL. You'll be introduced to the open source and commercial data science tools available. You'll also learn about the packages, APIs, data sets and models frequently used by Data Scientists.
Automated Reasoning: satisfiability	Coursera Course, EIT Digital (Online)	25h /July 2023	4	2	This course introduces SAT (satisfiability) including linear inequalities, truth tables of propositional formulas, propositional satisfiability and binary arithmetic to propositional logic conversions. It also explained SMT (SAT modulo theories) for beginners, and it also provided number of examples of how to apply SAT.
Data Science Methodology	Coursera Course, IBM (Online)	6h /August 2023	1	2	This course covers the understanding about Business Understanding and Analytic approach. In Business understanding it explained cross-industry data mining methodology, different phases of CRISP-DM and data science methodology, how to address business problems, analyzing data requirements with the help of a case study. This course also helped in understanding data content, data formats, and data sources prior to data collection and data preparation phases
ICE Y&H Knowledge Sharing	Online Webinar by Andrew Wilson	March 2023		2	The webinar was organized by ICE Yorkshire & Humber region. In this webinar the speaker discusses the aspects of

Temporary & permanent steel bridges					project delivery for both temporary and permanent works utilizing steel bridges. Main ideas discussed were Temporary and permanent bridges, Information required for design, Limitations of temporary and permanent bridges including span arrangements, Bearings and articulation, Bridge foundations, Installation and removal, Key risks, Broad Commercial Costs.
Engineering of Structures: Tension	Coursera Course, Dartmouth College (Online)	13h /March 2024	2	2	This module is part of an extensive course, and it explores tension and its importance in building structures. It covered the basics of tension, recognizing the role of ropes and cables in sustaining tension and identifying the definitions of the key glossary terms related to tension.
Total CFU			48		

SIGNATURES	
Prof. Dr.	SUPERVISOR: Prof. Stefania Costantini
	
Co. Prof. Dr.	CO-SUPERVISOR: Prof. Giovanni De Gasperis
	
Prof. Dr.	RESPONSIBLE OF THE REFERENCE GROUP: Prof. Alfonso Pierantonio
	

Date: 17 / 03 /2024


Signature of the Doctoral student