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Mauro Milella

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ESPERIENZA LAVORATIVA

TUTOR UNIVERSITARIO – UNIVERSITÀ DEGLI STUDI DI FERRARA – 2023 – Attuale – FERRARA, ITALIA

Tutor dei corsi di Programmazione per il corso di Matematica, e Algoritmi e Strutture Dati per il corso di Informatica.

SVILUPPATORE DI SOFTWARE – GAP – 07/01/2024 – 09/01/2024 – ITALIA

Sviluppo di un software end-to-end in Python, per proporre itinerari a partire da un database GTFS.

SVILUPPATORE WEB – INMM – 12/2022 – 04/2023 – FERRARA, ITALIA

Sviluppo di una web-app per il monitoraggio e la visualizzazione di dati fisiologici e ambientali.

LEADTHEFUTURE MENTEE – LEAD THE FUTURE MENTORSHIP – 09/2022 – Attuale

Tra i pochi studenti italiani selezionati per essere mentee di LeadTheFuture, un'organizzazione no-profit leader nella mentorship per gli studenti in ambito STEM. LeadTheFuture consente agli studenti più meritevoli di raggiungere i loro obiettivi e di contribuire alle loro comunità, fornendo loro una guida individuale da parte di mentori di grande impatto provenienti dai principali centri di innovazione STEM del mondo, come la Silicon Valley e il CERN.

INSEGNANTE PROGRAMMAZIONE COMPETITIVA – LICEO SCIENTIFICO A. ROITI – 2018 – 2020 – FERRARA, ITALIA

Lezioni di preparazione per le Olimpiadi Italiane di Informatica.

ISTRUZIONE E FORMAZIONE

11/2025 – ATTUALE
DOTTORATO IN MATEMATICA Università degli Studi di Modena e Reggio Emilia

11/30/2022 – 11/30/2024 Ferrara, Italia
LAUREA MAGISTRALE IN INTELLIGENZA ARTIFICIALE, DATA SCIENCE E BIG DATA Università degli Studi di Ferrara

Voto finale 110/110 e lode

2020 – 2023 Ferrara, Italia
LAUREA TRIENNALE IN INFORMATICA Università degli Studi di Ferrara

Voto finale 110/110 e lode

2015 – 2020 Ferrara, Italia
DIPLOMA MATURITÀ SCIENTIFICA Liceo Scientifico A. Roiti

PUBBLICAZIONI

2026

Semantic Embeddings for Modal Logic

The concept of similarity between formulas in formal logic does not have a universally accepted interpretation; intuitively, two formulas should be considered similar if their behaviour is similar, that is, if they agree on most models. In this paper, we propose a novel framework to assess formula similarity inspired by word embeddings in natural language processing. To test the properties of our embedding, we choose modal logic, which provides a natural compromise between propositional and first-order logic. The results of our proof-of-concept implementation suggest that it is possible to represent the behaviour of logical formulas as numerical vectors, regardless of the properties of the underlying frame. Our technique is easily transferable to other logical frameworks, including temporal, spatial, description logics, and, possibly, even first-order frameworks, paving the way for various potential applications.

Autori: P. Casavecchia, M. Milella, R. Monego, A. Paparella, G. Sciavicco, L. Serrentino | **Nome della pubblicazione**: Proceedings of the 27th Italian Conference on Theoretical Computer Science

2025

Temporal Association Rules from Motifs

(Relatore presso la Queen Mary University of London)

A motif is defined as a frequently occurring pattern within a (multivariate) time series. In recent years, various techniques have been developed to mine time series data. However, only a few studies have explored the idea of using motif discovery in temporal association rule mining, and only limited to rules that do not temporally relate motifs with each other. Interval-based temporal association rules have been recently defined and studied, along with the temporal version of the known frequent patterns, and therefore, rule extraction algorithms (such as APRIORI and FPGrowth). In this work, we first define a simple algorithm to discover motifs from a dataset of multivariate time series, and build over them a vocabulary of propositional letters; second, we show how apply the temporal version of association rule discovery on such a vocabulary. With a careful choice of motifs, their lengths, and the thresholds for propositional letter construction, the extracted rules turn out to be very natural, with a very high level of interpretability. We apply our methodology to time series datasets in the fields of hand signs execution and gait recognition, and we discuss the resulting rules from an interpretability point of view.

Autori: M. Milella, G. Pagliarini, G. Sciavicco, I.E. Stan | **Nome della pubblicazione**: 32nd International Symposium on Temporal Representation and Reasoning

2024

ModalFP-Growth: Efficient Extraction of Modal Association Rules from Non-Tabular Data

(Relatore presso l'Università degli Studi di Torino)

This paper explores the extraction of modal association rules from non-tabular data using a novel algorithm, ModalFP-Growth. By extending the FP-Growth algorithm to modal logic, ModalFP-Growth processes instances represented as Kripke models, facilitating efficient rule extraction from temporal, spatial, and spatio-temporal datasets. Each instance is transformed into a tabular form where worlds correspond to rows and literals to columns, enabling the application of the original FP-Growth. The algorithm, then, aggregates locally frequent itemsets from individual instances to identify globally supported itemsets across the dataset. We prove the soundness and completeness of ModalFP-Growth, ensuring that all and only frequent itemsets are included in the final output. Additionally, we present an open-source implementation within the Sole learning and reasoning suite. Experimental evaluations using Halpern and Shoham's Interval Temporal Logic on a public temporal dataset demonstrate the algorithm's practical efficiency and the interpretability of the extracted rules.

Autori: M. Milella, G. Pagliarini, G. Sciavicco, I.E. Stan | **Nome della pubblicazione**: 25th Italian Conference on Theoretical Computer Science | **Volume, numero, pagine**: vol. 3811, pagg. 241 -- 254 | **Editore**: CEUR-WS.org

2022

Multi-Models and Multi- Formulas Finite Model Checking for Modal Logic Formulas Induction

(Relatore presso l'Università degli Studi di Udine)

Modal symbolic learning is the subfield of artificial intelligence that brings together machine learning and modal logic to design algorithms that extract modal logic theories from data. The generalization of model checking to multi-models and multi-formulas is key for the entire inductive process (with modal logics). We investigate such generalization by, first, pointing out the need for finite model checking in automatic inductive reasoning, and, then, showing how to efficiently solve it. We release an open-source implementation of our simulations.

Autori: M. Milella, G. Pagliarini, A.Paradiso, I.E. Stan | **Nome della pubblicazione**: 4th Workshop on Artificial Intelligence and Formal Verification, Logic, Automata, and Synthesis | **Volume, numero, pagine**: vol. 3311, pagg. 81 -- 85 | **Editore**: CEUR-WS.org

2022

On Modal Logic Association Rule Mining

The most iconic duality of machine learning models is symbolic learning versus functional learning. While functional learning is based on a numerical approach to knowledge extraction and modelling, the purpose of symbolic machine learning is to extract knowledge from data in such a form that it can be understood, discussed, modified, and applied by humans, as well as serve as the basis of artificial intelligence applications. The typical problems associated with machine learning are classification and rule extraction; while classification can be dealt with using both functional and symbolic learning, rule extraction is essentially symbolic. One element common to nearly all definitions and tools for rule extraction is that they are applied to static datasets and based on propositional logic; unfortunately, very often real-world applications give rise to non-static sets of data (eg, temporal, spatial, graph-based data) and may require more-than-propositional expressive power. In order to extract association rules from non-static data, in this paper we propose a definition of modal association rules based on modal logic, and we study how a standard rule extraction algorithm such as APRIORI can be generalized to the modal case while keeping the properties of the canonical, non-modal case, namely, correctness and completeness.

Autori: I.E. Stan, G. Sciavicco, E.M. Velasco, G. Pagliarini, M. Milella, A .Paradiso | **Nome della pubblicazione**: 23rd Italian Conference on Theoretical Computer Science | **Volume, numero, pagine**: vol. 3284, pagg. 53 -- 65 | **Editore**: CEUR-WS.org

COMPETENZE

Linux | Vim | Natural Language Processing | Algoritmi e Strutture Dati | LaTeX | Git | C | Python (NumPy, Pandas, ScikitLearn, pySpark, Scikit-Learn, TensorFlow, Keras) | Julia | Matlab | Prolog | SQL

ONORIFICENZE E RICONOSCIMENTI

2020

Finale nazionale olimpiadi informatica a squadre – OIS

11° posto.

2019

Finale nazionale olimpiadi informatica individuali – OII

47° posto.

COMPETENZE LINGUISTICHE

Lingua madre: **ITALIANO**

Altre lingue:

	COMPRENSIONE		ESPRESSIONE ORALE		SCRITTURA
	Ascolto	Lettura	Produzione orale	Interazione orale	
INGLESE	B2	B2	B2	B2	B2

Livelli: A1 e A2: Livello elementare B1 e B2: Livello intermedio C1 e C2: Livello avanzato

Autorizzo il trattamento dei miei dati personali presenti nel CV ai sensi dell'art. 13 d. lgs. 30 giugno 2003 n. 196 - "Codice in materia di protezione dei dati personali" e dell'art. 13 GDPR 679/16 - "Regolamento europeo sulla protezione dei dati personali".