# Andrea Rafanelli

✉ andrea.rafanelli96@gmail.com | 🔗 andrea-rafanelli
⌨ andrearafanelli | 🌐 andrearafanelli.github.io

## PROFESSIONAL EXPERIENCE

**Visiting Researcher**                                                    *Amsterdam, NL*
*Vrije University of Amsterdam*                                           01/11/2023 – 01/05/2024
- Developed human-machine interaction project in the **Learning and Reasoning Group** at the Department of Computer Science.

**Data Scientist**                                                        *Genoa (GE), Italy*
*Kellify S.p.a*                                                          01/10/2020 – 20/10/2021
- Worked on image recognition and segmentation algorithms.

## EDUCATION

**Ph.D in Artificial Intelligence for Society**                           *Pisa (PI), Italy*
*Università degli Studi di Pisa*                                          01/11/2021 – 31/10/2024
- **Topic:** Mitigate machine learning problems in agent systems, such as limited data availability and lack of reasoning, by exploring Neuro-Symbolic AI techniques.
- **Thesis:** Towards an integration of learning and reasoning in agent and multi-agent systems.

**M.Sc Data Analytics**                                                   *Milan (MI), Italy*
*Università Cattolica Del Sacro Cuore*                                    01/10/2018 – 15/09/2020
- **Relevant coursework:** Neural network, Data mining, Stochastic modelling, Computational statistics, Statistical learning, Business analytics, Dynamic economics, Digital marketing.
- **Thesis:** *Dynamic pricing under competition in an e-commerce scenario: a demand learning and price optimization technique.*
- **Grade: 110/110**

**B.Sc Economics and Statistics**                                         *Turin (TO), Italy*
*Università degli Studi di Torino*                                        15/09/2015 – 10/09/2018
- **Relevant coursework:** Probability, Statistics, Data mining, Econometrics, Micro and Macro economics, Sampling theory, Financial markets.
- **Thesis:** *Evaluation techniques and their use in Italy to measure the effect of labor policies: a Difference in Difference method.*
- **Grade: 105/110**

## TECHNICAL SKILLS

**Languages** : Python, R, Prolog
**Packages** : Pandas, NumPy, Scikit-learn, Keras, Pytorch
**Databases** : SQL, MySQL
**IDEs** : PyCharm, RStudio
**Markup languages** : Markdown, LATEX
**Areas** : Machine Learning, Deep Learning, Data Visualization, Statistical Analysis, Data Preparation

## LANGUAGES

|  | Listening | Reading | Interaction | Speaking | Writing |
|---|---|---|---|---|---|
| **Italian** | Native language | | | | |
| **English** | C1 | C1 | C1 | C1 | C1 |
| **French** | B2 | B2 | B1 | B1 | B1 |

# PROJECTS

**Msc projects:**
*language: [R, Python]*

- **Cervical Cancer Detection [▤]**: developed multiple ML models (GLM, KNN, Random Forest) for detecting cervical cancer.
- **Credit Card Offer [▤]**: developed cluster analysis to identify different customer segments, and implemented logistic regression and decision tree to predict customers who accept credit card offers.
- **Flower Recognition [▤]**: created a CNN model able to classifies flower images into five categories.

## Dynamic Pricing (Msc thesis)
*language: [Python], packages: [scipy, sklearn]*                                    [▤] [Ω]

- Design a system for automatically predicting prices by adapting to market variations.
- Implemented a probabilistic model for sales prediction and formulated the pricing problem as a Markov Decision Process.
- Developed a value iteration algorithm for optimal pricing decisions.

## Covid Chest X-Ray (Covid CXR Hackathon)
*language: [Python], packages: [sklearn, cv2, skimage, pytorch, XAI-Library]*                [▤]

- Developed a predictive model to diagnose Covid-19.
- Implemented multiple predictive models: Random Forest classifier using clinical data, EfficientNet B3 model for chest X-ray image analysis, mixed model combining clinical and image data.
- Applied various explainability techniques: LIME for both clinical and image data, SHAP for clinical data, and saliency maps for image data.

## Emotion Recognition (PhD project)
*language: [Python], packages: [sklearn, pytorch, torchvision]*                          [Ω]

- Develop an emotion recognition model capable of identifying and classifying human emotions.
- Implemented a deep learning model using ResNet architecture with Squeeze-and-Excitation (SE).
- Achieved good performance in identifying happy and surprise emotions and mixed results for negative emotions.

## Multi-agent system for flood event detection (PhD paper)
*language: [Python, Prolog], packages: [sklearn, cv2, albumentations, skimage, pytorch, torchvision, redis]*         [▤][Ω]

- Design and implement a MAS capable of real-time analysis and alert generation for potential flood events.
- Utilized PSP-Net model for aerial image segmentation and developed a method to transform PSP-Net output into descriptive logical facts
- Implemented several agents: a Perceptor agent to interpret logical facts and determine flood status, a Weather agent to provide real-time weather information, and an Alert agent to process information and generate appropriate alert.

## Neural Logic Reinforcement Learning (PhD paper)
*language: [Python], packages: [pyswip, tensorflow, pygame, guizero]*                       [▤][Ω]

- Designed a framework where logical rules influence a reinforcement learning agent in exploring an environment.
- Implemented two types of agents: standard reinforcement learning agent (purely neural network-based), hybrid neuro-symbolic agent (combining neural network and logic rules).
- Developed a symbolic supervisor to handle obstacle avoidance and door detection.
- Created different evaluation metrics: i) room changes (exploration capability), ii) action randomness (navigation efficiency), iii) cumulative reward (performance, approaching, and finding targets), and iv) composite score (goal achievement capacity).

## Quality-of-Service Metrics for symbolic knowledge injection (PhD paper)
*language: [Python], packages: [sklearn, tensorflow]*                               [▤][Ω]

- Designed a set of quality-of-service (QoS) metrics for symbolic knowledge injection (SKI) algorithms, i.e. algorithms that incorporate symbolic knowledge into sub-symbolic models.
- Implemented a software API to enable their application to various SKI algorithms.

## Robustness of Knowledge Injection Techniques (PhD paper)
*language: [Python], packages: [sklearn, tensorflow]*                               [▤][Ω]

- Formulated a metric for measuring the robustness of SKI in neural networks.
- Implemented three data perturbation strategies to evaluate SKI robustness: sample drop, noise addition, and label flipping.
- Conducted experimental evaluations of the robustness metric across multiple datasets, injection methods, and perturbation types.

## CERTIFICATIONS AND SUMMER SCHOOLS

**23rd European Agent Systems Summer School** , Faculty of Information Technology, Prague *July 2023*
**ESSAI & ACAI 2023** , Faculty of Computer and Information Science, Lubljana *July 2023*
**Neuro-Symbolic AI Essentials** , IBM *February 2023*
**Models, Algorithms, AI and Beyond** , Jacob T. Schwartz International School for Scientific Research *July 2022*
**Reinforcement Learning in Python**, Udemy *April 2020*
**Deep Learning A-Z: Hands-on Artificial Neural Network**, Udemy *November 2019*

## SCIENTIFIC ACTIVITY

**Program Committee Membership for EXTRAAMAS 2024** , Auckland, NZ *May 2024*
**Program Committee Membership for AEQUITAS 2023** , Kraków, PL *October 2023*
**Program Committee Membership for TransAI 2023** , Laguna Hills, CA *September 2023*
**Panel at Women@ICLP 2023** , London, UK *July 2023*
**Program Committee Membership for EXTRAAMAS 2023**, London, UK *May 2023*
**Publication Committee Membership for ISM 2022**, Naples, IT *December 2022*

## PUBLICATIONS

[ARM+23]   Andrea Agiollo, Andrea Rafanelli, Matteo Magnini, Giovanni Ciatto, and Andrea Omicini. Symbolic knowledge injection meets intelligent agents: Qos metrics and experiments. *Autonomous Agents and Multi-Agent Systems*, 37(2):27, Jun 2023.

[ARO22]   Andrea Agiollo, Andrea Rafanelli, and Andrea Omicini. Towards quality-of-service metrics for symbolic knowledge injection. In Angelo Ferrando and Viviana Mascardi, editors, *Proceedings of the 23rd Workshop "From Objects to Agents", Genova, Italy, September 1-3, 2022*, volume 3261 of *CEUR Workshop Proceedings*, pages 30–47. CEUR-WS.org, 2022.

[CDG+24]   Stefania Costantini, Pierangelo Dell'Acqua, Giovanni De Gasperis, Francesco Gullo, and Andrea Rafanelli. NEMO - A neural, emotional architecture for human-ai teaming. In Emanuele De Angelis and Maurizio Proietti, editors, *Proceedings of the 39th Italian Conference on Computational Logic, Rome, Italy, June 26-28, 2024*, volume 3733 of *CEUR Workshop Proceedings*. CEUR-WS.org, 2024.

[DCD+24]   Pierangelo DellAcqua, Stefania Costantini, Abeer Dyoub, Giovanni De Gasperis, Andrea Monaldini, and Andrea Rafanelli. Empathy-aware behavior trees for social care decision systems. *Procedia Computer Science*, 239:1727–1735, 2024. CENTERIS  International Conference on ENTERprise Information Systems / ProjMAN - International Conference on Project MANagement / HCist - International Conference on Health and Social Care Information Systems and Technologies 2023.

[DGCR+23] Giovanni De Gasperis, Stefania Costantini, Andrea Rafanelli, Patrizio Migliarini, Ivan Letteri, and Abeer Dyoub. Extension of constraint-procedural logic-generated environments for deep Q-learning agent training and benchmarking. *Journal of Logic and Computation*, 06 2023. exad032.

[PGP+24]   Fabio Persia, Mouzhi Ge, Giovanni Pilato, Daniela D'Auria, Andrea Rafanelli, Stefania Costantini, and Giovanni De Gasperis. Leveraging DALI to refine route planning by dynamically avoiding risky pois. In *18th IEEE International Conference on Semantic Computing, ICSC 2024, Laguna Hills, CA, USA, February 5-7, 2024*, pages 351–354. IEEE, 2024.

[Raf23]   Andrea Rafanelli. Beyond traditional neural networks: Toward adding reasoning and learning capabilities through computational logic techniques. In Enrico Pontelli, Stefania Costantini, Carmine Dodaro, Sarah Alice Gaggl, Roberta Calegari, Artur S. d'Avila Garcez, Francesco Fabiano, Alessandra Mileo, Alessandra Russo, and Francesca Toni, editors, *Proceedings 39th International Conference on Logic Programming, ICLP 2023, Imperial College London, UK, 9th July 2023 - 15th July 2023*, volume 385 of *EPTCS*, pages 416–422, 2023.

[RCDG23]   Andrea Rafanelli, Stefania Costantini, and Giovanni De Gasperis. Neural-logic multi-agent system for flood event detection. *Intelligenza Artificiale*, 17:19–35, 2023. 1.

[RCG22]   Andrea Rafanelli, Stefania Costantini, and Giovanni De Gasperis. A multi-agent-system framework for flooding events. In Angelo Ferrando and Viviana Mascardi, editors, *Proceedings of the 23rd Workshop "From Objects to Agents", Genova, Italy, September 1-3, 2022*, volume 3261 of *CEUR Workshop Proceedings*, pages 142–151. CEUR-WS.org, 2022.

[RCG23]   Andrea Rafanelli, Stefania Costantini, and Giovanni De Gasperis. Experimenting an approach to neuro-symbolic RL. In Riccardo De Benedictis, Matteo Castiglioni, Diodato Ferraioli, Vadim Malvone, Marco Maratea, Enrico Scala, Luciano Serafini, Ivan Serina, Elisa Tosello, Alessandro Umbrico, and Mauro Vallati, editors, *Proceedings of the the Italian Workshop on Planning and Scheduling, RCRA Workshop on Experimental evaluation of algorithms for solving problems with combinatorial explosion, and SPIRIT Workshop on Strategies, Prediction, Interaction, and Reasoning in Italy (IPS-RCRA-SPIRIT 2023) co-located with 22nd International Conference of the Italian Association for Artificial Intelligence AIxIA 2023, November 7-9th, 2023, Rome, Italy*, volume 3585 of *CEUR Workshop Proceedings*. CEUR-WS.org, 2023.

[RCO22]   Andrea Rafanelli, Stefania Costantini, and Andrea Omicini. Position paper: On the role of abductive reasoning in semantic image segmentation. In Agostino Dovier, Angelo Montanari, and Andrea Orlandini, editors, *22nd International Conference of the Italian Association for Artificial Intelligence (AIxIA 2022), Udine, Italy, November 28-December 2, 2022*, volume 3419 of *CEUR Workshop Proceedings*. CEUR-WS.org, 2022.

[RMA⁺24a]  Andrea Rafanelli, Matteo Magnini, Andrea Agiollo, Giovanni Ciatto, and Andrea Omicini. An empirical study on the robustness of knowledge injection techniques against data degradation. In Marco Alderighi, Matteo Baldoni, Cristina Baroglio, Roberto Micalizio, and Stefano Tedeschi, editors, *Proceedings of the 25th Workshop "From Objects to Agents", Bard (Aosta), Italy, July 8-10, 2024*, volume 3735 of *CEUR Workshop Proceedings*, pages 20–32. CEUR-WS.org, 2024.

[RMA⁺24b]  Andrea Rafanelli, Matteo Magnini, Andrea Agiollo, Giovanni Ciatto, and Andrea Omicini. An empirical study on the robustness of knowledge injection techniques against data degradation. In Marco Alderighi, Matteo Baldoni, Cristina Baroglio, Roberto Micalizio, and Stefano Tedeschi, editors, *Proceedings of the 25rd Workshop "From Objects to Agents", Bard (Aosta), Italy, July 8-10, 2024*, volume 3735 of *CEUR Workshop Proceedings*, pages 20–32. CEUR-WS.org, 2024.

## DECLARATION

I hereby declare that all the details furnished above are true to the best of my knowledge and belief.