

Ph.D. research topic

- Title of the proposed topic: **Hybrid Argument Mining and Reasoning**
 - Research axis of the 3iA: Axis 1
 - **Supervisor (name, affiliation, email): Serena Villata (CNRS), villata@i3s.unice.fr**
 - Co-supervisor (name, affiliation): Marco Gori (UCA, University of Siena), marco.gori@unisi.it
 - The laboratory and/or research group: MASAAI & WIMMICS teams (Université Côte d'Azur, CNRS, Inria)
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Apply by sending an email directly to the supervisor and the co-supervisor.

The application will include:

- **Letter of recommendation of the supervisor indicated above**
 - Curriculum vitæ.
 - Motivation Letter.
 - Academic transcripts of a master's degree(s) or equivalent.
 - At least, one letter of recommendation.
 - Internship report, if possible.
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Context and research challenges

Argumentation pervades human intelligent behavior, and it is a mandatory element to conceive artificial machines that can exploit argumentation models and tools in the cognitive tasks they are required to carry out. The field of artificial argumentation [1] plays an important role in AI. The reason for this is based on the recognition that if we are to develop robust intelligent machines able to act in mixed human-machine teams, then it is imperative that they can handle incomplete and inconsistent information in a way that somehow emulates the way humans tackle such a complex task. To do so, artificial argumentation combines formal argumentation, based on critical reasoning, with human natural argumentation extracted through argument mining methods.

Argument(ation) mining (AM) [2] is the research field in artificial argumentation aiming at automatically processing natural language arguments and reason upon them. It aims at extracting natural language arguments and their relations from text, with the final goal of providing machine-processable structured data for computational models of argument. Roughly, each argument is a set of premises or assumptions that, together with a claim, is

obtained by a reasoning process. The overall goal of argumentation is to increase or decrease the acceptability of claims by supporting or attacking them with new arguments.

The PhD topic is structured around two main challenges:

1. enriching neural argument mining methods with formal knowledge to go behind purely statistical approaches. Boosting the automated identification of natural language arguments and their relations;
2. automatically assessing the quality of argumentation structures by combining both symbolic (knowledge-driven) and neural (data-driven) methods for argument ranking as well as for argument pairwise classification;

Current AM models are shown to learn linguistic patterns or cues rather than a real semantic understanding of the arguments. For instance, a model could predict a relation correctly, but it cannot explain the reasoning why the two linked components are in a relationship, since the required warrants are not explicitly mentioned in the text. Current classification algorithms can therefore be effective until a certain point, where the relation can be inferred from explicit mentions in the text. Furthermore, establishing an argumentative link between two (or more) different arguments is mandatory to obtain a full argumentation framework (e.g., a graph representation of a political debate) able to capture possible inconsistencies (e.g., self-attacking arguments, rebuttal on points supporting the candidate's viewpoint in political debates) and fallacious arguments (e.g., *ad hominem* attacks), at the basis of research challenges on argument quality. Graph Neural Networks (GNNs) [3] will be investigated in this direction, as they represent a natural choice given the graph-based structure of the argumentation, with a particular focus on the use of GNNs as a model of neural-symbolic computing. The goal of this PhD program is to tackle these research challenges.

Expected skills

The candidate should be a Master student in an AI, NLP and/or Machine Learning program, with a strong background in computer science and mathematics. Programming skills are required. Fluent English required, both oral and written. French is appreciated but not mandatory.

References

[1] Katie Atkinson, Pietro Baroni, Massimiliano Giacomin, Anthony Hunter, Henry Prakken, Chris Reed, Guillermo Ricardo Simari, Matthias Thimm, Serena Villata: Towards Artificial Argumentation. *AI Mag.* 38(3): 25-36 (2017).

[2] Elena Cabrio, Serena Villata. Five Years of Argument Mining: a Data-driven Analysis. *Proceedings of 27th International Joint Conference on Artificial Intelligence (IJCAI 2018)*, pages 5427-5433.

[3] Franco Scarselli; Marco Gori; Ah Chung Tsoi; Markus Hagenbuchner; Gabriele Monfardini, The Graph Neural Network Model, *IEEE Transactions on Neural Networks* (Volume: 20, Issue: 1, January 2009)

