Computational Models of Argument
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Toward the Argument Web of Science

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Introduction. This paper ties together the three projects undertaken to progress towards an Argument Web [1] of Science: a knowledge graph in which information from scholarly publications is represented in arguments that are dereferenceable URIs and linked together. To seed this process, we have explored Argument Mining (AM) [2] to automatically extract the argumentative structure of scientific articles in the form of components and relations from text. This has required three steps: benchmarking techniques, recombinative mechanisms for integrating argument mining systems, and cross-document argument mining.

Benchmarking Argument Mining. First of all, we needed a way to evaluate argument miners in a unified way. Therefore, we developed **BAM** [3], a **B**enchmark for **AM**, based on a four-stage pipeline [4]: *sentence classification*, *boundary detection*, *component identification*, and *relation prediction*.[2] For these tasks, we determined a metric to evaluate each independently. Thus, we can also represent how much of the pipeline a given argument miner covers. We showcased BAM by evaluating five AM systems.

Improving Argument Mining. As a next step, with a benchmark available, we focused on improving existing AM tools without reinventing the wheel. To this end, we devised the **DREAM** framework [5].[3] It provided a way to **D**eploy **R**ecombination and **E**nsembles for **A**rgument **M**ining and made use of the implementation of BAM. We experimented with using ensembles for the individual tasks in the AM pipeline and recombining argument miners by allowing the substitution of their intermediate results and, thus, input for subsequent steps. Our results showed that both methods—recombinations and ensembles—could lead to improved accuracy.

Extending Argument Mining. For the third project, we considered how to extend AM to form multi-document argument graphs. This resulted in **MIDAS**, **M**ining **I**nter-**D**ocument **A**rgument in **S**cientific papers.[4] We augmented an argument-annotated corpus of scientific papers [6] to include inter-document argumentative relations explicitly (i.e., relations involving more than one document) and published it using Semantic Web technologies. Then, we evaluated three argumentative relation prediction approaches—a

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[2] https://gitlab.ifi.uzh.ch/DDIS-Public/BAM
[3] https://gitlab.ifi.uzh.ch/DDIS-Public/DREAM
[4] https://gitlab.ifi.uzh.ch/DDIS-Public/MIDAS

rule-based, a transformer-based, and LLM/prompts-based—on the original dataset. Furthermore, we also compared them on the disjoint subsets of relations within a single document (intra-document) and those across multiple documents (inter-document), finding statistically significant differences. This signals that for relation prediction, a distinction should be made between the two cases. Finally, this project provided a resource in the extended dataset for future exploration of inter-document argumentative relation prediction.

Conclusions. This work lays a foundation for an Argument Web of Science by supplying some of the tools necessary for its construction. First, the benchmark **BAM** [3] is intended to help users identify the best-suited AM systems for automatically extracting arguments from natural language text by assessing various aspects. Next, **DREAM** [5] seeks to improve the state of the art without introducing any new techniques but rather combining those already available, and, thus, to provide more accurate AM systems for information extraction. Finally, **MIDAS** aims to put the focus on inter-document argumentative relation prediction in order to combine argument graphs from single documents into a multi-document Argument Web. Even though we still lack an end-to-end pipeline from natural language text in scientific publications to an argument graph, we hope that we provided useful tools for progress in that direction. The next steps would be to curate a larger annotated dataset and use it to seed the Argument Web of Science.

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