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# Neva – Extension Visualization for Argumentation Frameworks

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Many combinatorial search problems, such as finding all extensions of an argumentation framework (AF) for a semantics, result in a large solution space. Nowadays, systems compute these solutions very efficiently [1]. However, the enormous number of answers is very difficult to cope with by users. Recently, Rudolph et al. [2] proposed a framework for *faceted answer set navigation* where, given an answer set program, atoms can be interactively selected or excluded in order to navigate towards desired answer sets.

A standard way to visualize argumentation extensions is to highlight accepted arguments in the argumentation framework, but this method only allows to represent one solution at a time. Interesting insights of a solution set, such as which arguments usually are accepted together, or which never appear in the same extension (under a given semantics), can only be answered by further processing the solution sets.

The system `Neva` follows a novel approach in the visualization and analysis of argumentation extensions. Based on data mining algorithms, `Neva` identifies inner patterns in the solution space, and helps users to find the interesting attributes for further investigation. Within `Neva`, answer sets are conceived as data points in a high-dimensional space, which are projected to a plane for visualizing their distribution. The input for `Neva` is a set of answer sets as produced by the system `aspartix` [3] with the ASP solver `clingo` [4], i.e. sets of answer sets with predicates $\mathtt{in}(a_i)$ for all arguments $a_i$ to be in the extension of a given semantics. Additionally, the AF in `.apx` format is required. In the data process, datasets are transformed into numerical representations by a one-hot-encoding. Then, using Euclidean distance, the system provides the options to cluster via DBscan [5] or Kmeans. `Neva` has a variety of functions for different analysis requirements. The main interface of the system shows the data distribution in the whole space and the feature attributes w.r.t. different clusters and semantics separately. In addition, there are two buttons that can trigger argument-centered analysis and argument correlation analysis (i.e. correlation matrix and its clustering). If users want to analyze their own data, an upload component is provided at bottom on this page.

For first tests on the system `Neva` we used the benchmarks from ICCMA-2017 [1]. Figure 1 presents an interactive interface that illustrates the argument occurrences in the whole answer set space and analyzes answer sets that contain the selected argument. On the upper panel, options appear on the left and can be used to define the form of the bar plot on the right. These occurrence rates mean the percentages of answer sets in the whole dataset that contain the selected argument in question. Secondly, the radio items can decide if all the arguments will be included in the bar chart. Here, the option "interesting" focuses on those arguments whose occurrence rates are neither 100 % nor 0%. Below this, there is a check box that can control the order of attribute bars in the right graph. After finishing these decisions, the bar chart is created and users can select a specific argument by clicking on the bars. On the lower panel, the left picture shows the distribution of those answer sets containing the selected argument in two-dimensional space, while the right pie plot shows how they distribute over the clusters.

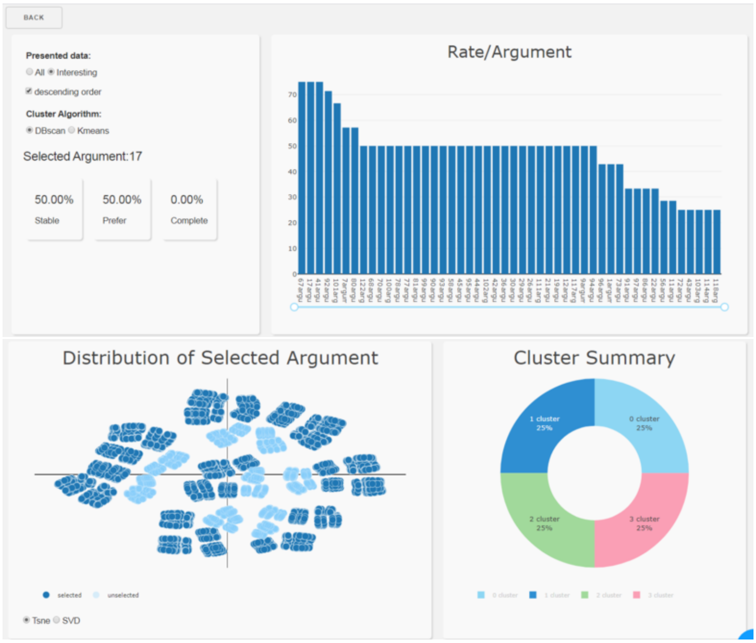


**Figure 1.** Attribute Analysis

The source code of our system is freely available at `https://github.com/Lexise/ASP-Analysis` and the online `Neva` is provided at `https://asp-analysis.herokuapp.com/`. It might be updated in the future as our research continues.

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## References

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