Towards Automated Identification and Analysis of Argumentation Structures in the Decision Corpus of the German Federal Constitutional Court

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Abstract — Argumentation is an essential task in every scientific discipline. The development of strong and convincing argumentation as well as the analysis of existing argumentation structures is important in the field of humanities, and especially in the field of jurisprudence. Judicial argumentation requires sophisticated intellectual effort and the knowledge of as much potentially relevant background information as possible. Considering that the fulfillment of this task is limited by the natural human information processing capacity, the field of digital humanities investigates how such information-intensive and time-consuming tasks can be supported by computers. Against the background of the ever-growing availability of different corpora of jurisdiction in Germany, a software prototype supporting automated identification, analysis and recommendation of argumentation structures in electronically available corpora of jurisdiction is currently developed in the project ARGUMENTUM. In this article, we present the basic concept for the preparation and processing of the decision corpus of the German Federal Constitutional Court which shall provide the basis for the future ARGUMENTUM prototype.

Keywords — argumentation mining, argument mining, NLP, jurisprudence, eHumanities, digital humanities, text mining

I. Introduction

Argumentation is an important intellectual activity and, furthermore, an essential task in the context of research in every scientific discipline. In arguments, justifications and refutations of statements are developed in order to convince other persons of the trueness or falsity of a certain statement. This is of special importance in the humanities as detailed and convincing explanations of subjective interpretations of sources such as texts and pictures play a central role in humanistic research. In the context of jurisprudence – as one particular representative of the humanities which is of considerable practical relevance for every human being taking part in social life – it is a central task to analyze court decisions representing aggregated and formalized argumentation structures. Besides these goals of theoretical jurisprudence, it is crucial for legal practice to identify especially those arguments which support specific goals; e. g. arguments which support a client to succeed in a lawsuit.

However, the analysis of argumentation structures in court decisions is a complex intellectual process which is bound to the natural limitations of human information processing capacity. This results in the fact that the preparation of argumentation structures is only based on those legal cases which a lawyer or jurist is familiar with. Moreover, such analyses commonly require a considerable amount of time. Against the background of the improving electronic availability of an ever-growing corpus of jurisdiction in Germany, the digital humanities project ARGUMENTUM aims at exploring the potential and the boundaries of methods and techniques from computer science and artificial intelligence for innovative applications in the *digital humanities*, especially for argumentation [1]. Furthermore, the identified potential shall be realized by a means of an innovative software prototype supporting automated identification, analysis and recommendation of argumentation structures in the decision corpus of the German Federal Constitutional Court (in German: *Bundesverfassungsgericht, BVerfG*).

It is the *goal* of this article to present a concept for the preparation and processing of the electronically available decision corpus of the BVerfG for the identification, analysis and recommendation of argumentation structures by means of argumentation mining techniques [2]. Our concept provides the fundament for the future ARGUMENTUM software prototype. We ground the development of the concept on a design-oriented research approach [3]. The development is based on conceptual considerations concerning related work in the field of argumentation mining, on the results of expert interviews concerning the BVerfG decision corpus and, moreover, on an in-depth analysis of the specific chartacteristics of the underlying corpus using a representative sample of decisions.

This paper is *structured* as follows: After this introduction, related work in the context of argumentation mining is presented in section two. Then, in section three the decision corpus of the BVerfG and its particular characteristics and structure are introduced as the fundament of the ARGUMENTUM concept. Section four introduces the concept by giving an overview at first and then explaining the different steps for the preparation and processing of the decision corpus in more detail. Section five discusses our concept and explains different implications on the development of the future software prototype before section six concludes the paper and gives an outlook on future work.

II. Related Work on Argumentation Mining

The term *argumentation mining* describes technical approaches for the identification and analysis of argumentation structures in electronic texts. This topic has gained importance in recent years and has mostly been investigated considering the field of jurisprudence [4, 5]. In this context, interesting and well-performing text mining approachs for the identification and analysis of argumentation structures based machine learning approaches like *Support Vector Machines* (SVM) have been proposed [2, 6] and applied using corpora of international jurisprudence [7]. Furthermore, a markup language for argumenation structures – the *Argument Markup Language* (AML), and software prototypes using AML for the representation of argumentation – the so-called *Araucaria* system [8] – based on well-known argumentation patterns like the Toulmin Scheme [9] or the schemata by Walton [10] have been proposed as a fundament for argumentation mining.

However, approaches in literature so far typically focus on argumentation in English language and on the so-called *Common Law* or *Case Law* jurisdiction [11] as the typical legal system in the Anglosphere. In contrast to that, the ARGUMENTUM concept introduced in the following is supposed to support argumentation mining in the BVerfG decision corpus (German language) and to consider the characteristics of a different legal system – the so-called *Civil Law* or *Codified Law* jurisdiction which coins the German legal system. In the following section, the structure and important characteristics of the BVerfG decision corpus are introduced and discussed.

III. The Decision Corpus of the German Federal Constitutional Court

Since it is a major goal of the ARGUMENTUM project to preprocess the electronically available decisions of the BVerfG – a large text corpus with more than 5000 decision from 1998 until today, available at www.bundesverfassungsgericht.de – for an automated identification, analysis and recommendation of argumentation structures, this section presents essential structural characteristics of the corpus. The BVerfG decisions typically have the following structure comprising five sections:

1. *Guiding principles*: This section contains an abstract of the decision's central statements but does not include any reasoning why the specific decision has been taken.

2. *Title of judgment*: Members of the court, participants of a lawsuit and the subject matter are presented.

3. *Tenor*: This section contains the court's decision concerning the matter of dispute. It may also comprise statements about provisional enforceability and costs of the proceedings.

4. *Statement of facts*: The agreed Statement of Facts, the issues under dispute, and any previous legal proceedings that may exist in the context are presented in this section.

5. *Reasons for the decision*: Finally, the court's decision described in the Tenor is justified. This section contains the details of argumentation in a decision provided by the court.

Whereas content in the sections 1 to 4 usually exists in the form of free text passages, section 5 typically comprises a more detailed substructure; sentences which are connected either in terms of content or regarding argumentative relations are concentrated in consecutively numbered paragraphs. In order to interpret a decision, it is important to investigate its *admissibleness* (Zulässigkeit) and its *foundedness* (Begründetheit). While admissibleness is primarily concerned with formal criteria of the lawsuit, i. e. whether an issue lies within the court's range of authority, foundedness expresses the court's holding in a specific case. Apart from only a few exceptions, the BVerfG decision corpus is consistent in terms of the presented structure and can be expected to provide an execllent basis for automated rule-based and also statistical processing. Furthermore, the consistent use of legal language and the fairly standardized linguistic style supports the goals of the ARGUMENTUM project.

IV. Research Method

In order to develop our ARGUMENTUM concept as a basis for the future software prototype, we consider the current state of the art in argumentation mining as one field of application of Natural Language Processing (NLP) techniques as well as the specific characteristics of the BVerfG decision corpus. Guided by several preceeding expert interviews with our project partner, the *Institute for Law and Informatics* (IFRI) at *Saarland University* which hosts the electronic corpus, we conducted an in-depth analysis of the BVerfG decisions based on a representative sample of 60 randomly picked decision documents as a starting point for the identification of reliable linguistic features for automated identification, analysis and recommendation of argumentation structures. According to the *Central Limit Theorem* (CLT) this random sample can be expected to support an appropriate and feasible exploratory investigation [12]. Against this background, we developed the ARGUMENTUM concept presented in the following as a basis for the future prototype.

V. The ARGUMENTUM Basic Concept

A. Overview

Based on important preliminary work in the field of argumentation mining by Moens et al. [4], Wyner et al. [5] and Mochales and Moens [6], we adopt available argumentation mining concepts and extend them to the specific characteristics of the BVerfG decision corpus. In addition to common methods for identifying argumentative sentences and determining their parts of speech (PoS), we draw particular attention to content summarizations, to sentiment analysis for both overall decisions and individual sentences, and to fine-grade analysis for each sentence. Figure 1 presents an overview of the ARGUMENTUM basic concept which serves as a framework for the identification, analysis and recommendation of argumentation structures in the corpus and which comprises six phases.

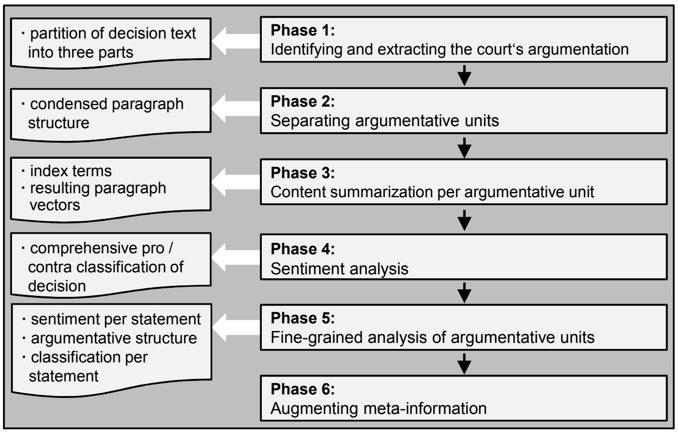

Fig. 1. Overview of the ARGUMENTUM Basic Concept

Phase 1: As a first step, it is necessary to identify all sentences in a decision that may contain argumentative propositions. It is then required to extract those sentences and separate them from non-argumentative statements for further analysis.

Phase 2: Next, the extracted text passages need to be separated into smaller argumentative units in order to be accessible for a more detailed analysis in phase 5. Since the decisions already comprise a structure based on numbered paragraphs, this particular structure is adopted for the moment. Decisions are, thus, split into constitutive paragraphs and consolidated.

Phase 3: In order to facilitate an automated identification and analysis of "related" arguments based on their content, in this phase, a paragraph is mapped onto a vectorial representation of its index terms based on a Vector Space Model (VSM).

Phase 4: Before single paragraphs and individual propositions can be analyzed in more detail in the next phase, we first perform a sentiment analysis to identify the court's holding towards the case at hand.

Phase 5: After the preparatory work carried out in the first four phases, we now draw attention to a fine-grained analysis of individual paragraphs and sentences based on the ideas in [6] considering the specialities of the German language. This analysis involves among other things a classification of propositions as well as the relation between different arguments.

Phase 6: Finally, the last step is concerned with structuring and saving the information gathered in the previous analysis steps. Providing this information in a structured form is crucial since it constitutes the basis for the different applications of the future prototype.

B. Phase 1: Identifying and extracting the court's argumentation

Regarding the general structure of BVerfG decisions, it can be concluded that argumentative statements can only appear in the following three places: *Guiding principles*, *Statement of facts*, and *Reasons for the decision*. Since the Guiding principles only present a summarization of the final holding without a justification and since the Statement of facts contains subjective argumentation and the claims of participants of the lawsuit, it is sufficient to focus on the *Reasons for the decision* ("reasoning") in order to identify the court's argumentation. Against this background, the entire decision can be divided in three parts: first the beginning of the document (including Guiding principles, Title of judgment, and Tenor) until the beginning of the reasoning, the reasoning itself, and eventually the end of the document, i. e. the entire text that follows the reasons until the end of the decision. To make use of this three-part separation, the first task entails the automated identification of the reasons. It is possible to simply perform a string match for the heading "Gründe:" (including the colon, German for *reasons*) which appears uniquely once in each decision and introduces the section containing the reasoning. For the purpose of identifying the end of the decision's reasoning, we investigated the last sentence of every document in our decision sample. As Table I shows, the most expressions allow for a string-based matching.

TABLE I. TYPICAL EXPRESSIONS AT THE END OF REASONING

Expression	**Sample count**
„This decision is irrefutable.“ („Diese Entscheidung ist unanfechtbar.“)	42
„[...] reimbursement of expenses [...]“ („[…] Auslagenerstattung […]“)	5
„[...] reimbursement of (necessary) expenses [...]“ („[…] Erstattung der (notwendigen) Auslagen […])“	3
„The decision was issued unanimously.“ („Die Entscheidung ist einstimmig ergangen.“)	3
„[...] necessary expenses were reimbursed [...]“ („[…] notwendigen Auslagen erstattet […]“)	2
Other expressions	5

In every analyzed decision in the sample, we found that the reasoning is always immediately followed by the names of the judges in charge and, after this listing, potentially some more text. So to circumvent the problem of ambiguous wordings, it seems feasible to utilize a word list that contains the names of all judges at the BVerfG from 1998 until today which can be easily build up by extracting all the names from all decision documents. The occurrence of one of these names followed by another name from this list provides an adequate indicator for the end of reasoning. Assuming that statements contained in the *Reasons* section are presented in linear order and that they are not scattered across the document (which was the case in every document we analyzed), it is sufficient for argumentation structure analysis to extract the entire text between the identified beginning and the identified end to separate the decision's argumentation from the text which is not important for argumentation analysis.

C. Phase 2: Separating argumentative units

As noted above, it is necessary to separate the whole argumentation part (as extracted in phase 1) into argumentative units by considering the inherent paragraph structure of a decision. The paragraph structure in the BVerfG decisions strongly correlates with the structure of argumentative units as regards content – or more precisely – an argumentative unit concerning one topic commonly represents one paragraph. However, in many complex argumentations a hierarchical structure of an argument can be identified. An argumentative unit concerning one topic can be separated into smaller argumentative statements as its constitutional parts. In the BVerfG decisions corpus such relations are often signalized by the usage of different mark-ups and numberings of paragraphs. However, the mark-up of the paragraph structure also depends on the type of decision documents. Important types are *judgement* (Urteil), *chamber decision* (Kammerbeschluss) and *senate decision* (Senatsbeschluss). For the initial concept development, we consider the typical structure of a *judgement* for the separation of argumentative units as this decision type possesses the most comprehensive paragraph structure. The other decision types often contain subsets of this structure. Table II presents the markups of the hierarchical stucture of judgements.

TABLE II. STRUCTURING HIERARCHY IN JUDGEMENTS

Level	Reasons:
1st	**A.** first level: Latin capital letters + "**.**"
2nd	**I.** second level: upper Roman numerals + "**.**"
3rd	**1.** third level: Arabic numerals + "**.**"
4th	**a)** fourth level: small Latin letters + ")"
5th	**aa)** fifth level, double small letters + ")"
6th	**(1)** sixth level: Arabic numerals in brackets
7th	**i)** seventh level: small Roman Numerals + ")"
8th	**α)** eighth level: Greek letters + ")"

As the structuring is not totally consistent throughout the whole corpus – especially in the deeper regions of the hierarchy beginning with the 5th level – while the first four levels are mostly consistent, we consider the first four hierarchy levels for our concept. Thus, we separate arguments based on the given numbering concerning the first four levels for our first prototypical implementation. The usefulness and feasibility of this approach as well as the quality of gained results based on this approach have, however, to be investigated later on by means of application and empirical evaluation of the future prototype.

D. Phase 3: Content summarization per argument unit

One of the major objectives of ARGUMENTUM is to enable a user to perform a content-based retrieval when looking for arguments, which are "similar" to a given one. With respect to argumentation, the term "similarity" normally involves a deep textual understanding of argumentative relations. However, it can be very useful to narrow down the set of candidate paragraphs by means of their content. For this purpose, we aim at representing each argumentative unit as a vector of relevant index terms in a *Vector Space Model* [13]. Regarding the specific needs in ARGUMENTUM, we use the following sequence of analysis steps which consider peculiarities of the BVerfG decision corpus and the German language.

1. Assuming that textual keywords which transport important content of a paragraph are nouns or noun phrases, we focus on the detection of these parts of speech. Therefore, PoS tagging is used to identify nouns, followed by Named Entity Recognition (NER) to determine proper nouns [14]. Regarding characteristics of the German language, all words that start with a capital letter and have not been tagged by PoS or NER – except those at the beginning of a sentence – are considered as nouns as well.

2. Next, we determine groups of words (so-called n-grams), i. e. noun phrases in addition to the nouns identified in step 1. Considering n-grams usually yields more significant index terms as the following example shows: the term "act" on its own does not provide a good index term as it is very frequent in common usage. However, the 2-gram "negligent act" provides a much more specific index term. In order to detect n-grams, we start from the nouns that we already identified and consider a maximum of two preceeding words. Groups of words that comprise more than three words are quite unusual in German and often express a very specific (unique) circumstance. Using information about these words' part of speech, we can also stop an analysis if we encounter words of the classes "verb" or "article" for instance, as a word sequence containing such words can not form a noun phrase.

3. To exclude specific words from being considered as index terms, we use a stop word list. This is useful as the corpus contains several words which occur frequently but which are not very meaningful, e. g. the general term "Gericht" (English *court*) is often used in references to previous decisions but does not seem to be very important in the context of summarizing a paragraph's content.

4. The final step applies a stemming algorithm to the remaining words respectively groups of words to reduce them to their basic forms. This causes e. g. plural and singular forms of the same word to be mapped on a single index term. In addition to that, we also consider performing a decomposition of compound nouns, e. g. the German term "Gesellschafterhaftung" (English *accessory liability*) is decomposed into "Gesellschafter" and "Haftung" thus extending the set of index terms. Finally the TF*IDF method is used to compute a statistical weight for every term [15]. Those weights are used as dimensional values in the vectorial representation of a paragraph.

Executing this four-step sequence results in an individual vector per argumentative unit. The dimensional values of each vector equal the TF*IDF-weight set of index terms of the entire corpus. Determination of argumentative units that resemble other given units in terms of content can be achieved by calculating a similarity measure, e. g. Cosine Similarity or the Euclidean distance for the vectors.

E. Phase 4: Sentiment analysis

Sentiment analysis is an important step towards understanding whether a court's holding turns out to be *pro* or *contra* with respect to the overall decision under discussion. In Phase 4 this analysis is performed for the entire reasoning of a decision (we call this the "absolute sentiment"). Therefore we aim at automatically identifying whether an appeal is admissible or not, and in case it is admissible we look at whether it is also founded or not. Since the German Federal Constitutional Court only uses a few different expressions for classifying a decision, automation can be achieved by conducting a string-based matching for the following expressions (Table III).

TABLE III. EXPRESSIONS FOR IDENTIFYING ADMISSIBLENESS AND FOUNDEDNESS

Expressions	Sample count
Inadmissible	
„[...] constitutional complaint [...] not accepted for decision [...]“ („[...] Verfassungsbeschwerde […] nicht zur Entscheidung angenommen [...]“)	37
„The request for remission of provisional order will be discarded.“ („Der Antrag auf Erlass einer einstweiligen Anordnung wird abgelehnt.“)	2
„The request will be discarded.“ („Die Anträge werden verworfen.“)	1
Admissible	
Founded	
„[...] violate the appellant in his right formulated in article [...]“ („[...] verletzen den Beschwerdeführer in seinem Grundrecht aus Artikel [...] des Grundgesetzes [...]")	16
„[...] is incompatible with article [...] of the constitution.“ („[...] mit Artikel […] des Grundgesetzes unvereinbar […]")	1
Unfounded	
„The constitutional complaint will be discarded.“ („Die Verfassungsbeschwerde wird zurückgewiesen.“)	2
„[...] is compatible with article [...] of the constitution.“ („[...] mit Artikel […] des Grundgesetzes vereinbar […]")	1

Aside from the court's holding, the actual issue under discussion can be extracted at this point as well and can be saved in addition to the results of the sentiment analysis. The same wording in the section *Title of judgement* always states the issue which can also be automatically extracted: "*In the lawsuit concerning the constitutional complaint* [... *representative/s* ...] *against* [... **issue** ...] *the (x). chamber* [...] *has decided* [...]“. It should be noted that at this point in the analysis it is not possible to answer the question which arguments within the court's holding argue *in favour of* or *against* the issue under discussion. This is what we call "relative sentiment" when analyzing sentiment per argumentative unit in Phase 5.

F. Phase 5: Fine-grained analysis of argument units

As a first step towards an automated fine-grained analysis, we aim at classifying each sentence within a paragraph as either a *proposition* or an *explanation*. *Proposition* in that case means a newly declared statement that expresses an opinion held by the court. *Explanation* denotes the support that is provided to back this proposition. From the manual analysis of the sample's paragraphs, we draw the following conclusions:

1. Propositions in this context typically comprise only one sentence and only in rare cases more than three consecutive sentences. In contrast to that, explanations are more extensive and typically consist of more than one sentence.

2. Propositions almost always form the beginning of an argumentative unit within a decision, i. e. they formulate its first sentence. Explanations typically follow immediately on propositions but can span several paragraphs and normally end once the next proposition is stated.

3. In several cases, we observed that a proposition and its related explanation are contained in only one paragraph. However, those occurrences seem to be independent of any (sub)-numberings and furthermore, no decisive structure could be identified for when this case appears.

From these conclusions follows that the mere structure of a decision is not sufficient for the identification of propositions and explanations. Therefore, we need to apply methods that work on linguistic features of a decision's text. Mochales and Moens [6] apply a *Support Vector Machine* (SVM) along with sophisticated textual features to a similar problem when classifying premises and conclusions according to the Toulmin argumentation scheme [9]. Starting from this approach, we aim at extending their method by the use of linguistic patterns comprising expressions which are common in German legal language. Such patterns can be expected to form a precise means for the identification of specific linguistic characteristics and constitute a powerful SVM feature complementing the ones proposed in [6].

In addition to using a SVM along with linguistic features extracted from the decision text, we will examine the possible implementation of a *Context-Free Grammar* (CFG) in order to automatically derive the underlying argumentative structure of a decision (*argumentative parsing*). According to [6], the effectiveness of using a CFG strongly depends on the corpus to be processed: only if it is sufficiently homogenous, production rules that cover the structural text characteristics at hand can be formulated as part of a CFG. In order to determine whether the BVerfG corpus exhibits such homogeneity, further investigation needs to be carried.

As mentioned before in *Phase 4: Sentiment analysis,* we need to perform a more detailed analysis in addition to the previously determined "absolute sentiment" in order to obtain a "relative sentiment" per paragraph. This sentiment is "relative" as it supports the classification of every proposition as *pro* or *contra* regarding the overall issue under discussion and its absolute sentiment. For example, if we determine a specific proposition as *pro* and the superior discussion is classified as *contra*, then the pro-proposition supports declining the issue. Basic methods for determining sentiment on a fine-grained level have been proposed in literature, e. g. in [16], and can serve as a starting point for our implementation.

G. Phase 6: Augmenting meta-information

In the last phase, all developed (meta-)information which have been gathered need to be stored in a structured way. The content-related meta-information is contained in the vectors representing each argumentative unit paragraph and which are based on the extracted index terms. In order to store individual vectors in such a way that they can easily be compared to every other vector in the collection, we plan to use a term-document matrix. This matrix comprises *m* columns and *n* rows, where *m* denotes the number of terms in the whole term collection and *n* denotes the quantity of documents that constitute the collection. A matrix entry w_{ij} represents the TF*IDF weight of term *i* in document *j* if it exists, and 0 otherwise. Thus, every row forms a document vector d_{ij} in an *m*-dimensional vector space. Based on this representation, it is possible to directly identify the terms which are shared by two vectors d_{ij} and d_{kl} by using adequate underlying similarity measures which considers TF*IDF values. Thus, the content of all argumentative units can be compared and similar arguments as regards content can be identified. Besides the information which are necessary for a content-based retrieval, much more data is generated during the individual phases of the analysis, e. g. during the classification of part of speeches (PoS tagging in phase 3). This information can be saved using a markup language like XML. Markups in XML can be applied in every analysis step in order to save the information produced and it can, furthermore, be used to define and tag hierarchical structures in decisions. For example, paragraphs or sentences could be marked by tags that express their sentiment or classify them as “premise”, “conclusion” etc.

VI. DISCUSSION

As mentioned before, the ARGUMENTUM basic concept is supposed to serves as a fundament for an automated identification and analysis of argumentation structures. The underlying presuppositions of the concept have been gathered based on expert interviews and on the in-depth analysis of a randomized sample of 60 decisions from the corpus. However, after the implementation of the future prototype it has to be evaluated how well the chosen approaches work for the identification and analysis of argumentation structures in the BVerfG decision corpus. Application experiences will help to improve the underlying concept, implementation as well as the results. After automatically processing the entirety of decision documents, also the accuracy of each individual concept phase can be reviewed and evaluated. Lessons learned from this evaluation can be used to refine the concept and to adapt it to additionally identified characteristics of the corpus. We assume that refinements concerning the concept will affect the detailed parameterization of the applied text mining methods, e. g. how to treat the markup and numbering of texts paragraphs for identifying argumentative units.

VII. CONCLUSION AND FUTURE WORK

This contribution introduced a concept for argumentation mining in the decision corpus of the German Federal Constitutional Court supporting the identification and analysis of argumentation structures. A concept which focuses on characteristics of the German language and the German law system was developed based on conceptual consideration, expert interviews and an in-depth analysis of the characteristics of a randomly picked sample of decision texts. The improving electronic availability of growing corpora of jurisprudence offer considerable potential for automated text processing of judicial texts and, thus, also for the further development of digital humanities in general. In the future, the ARGUMENTUM software prototype supporting the identification, analysis and recommendation of argumentation structures will be developed and, furthermore, more details on the potential and boundaries of NLP techniques in the context of humanities will be investigated.

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