Appendix I: Methodology

The empirical analysis focuses on 18'690 rulings of the Swiss Federal Tribunal published in the official compendium between 1954 and 2016. Assuming it took five minutes on average to read one decision and to decide whether it pertained to international law, reading this case law would have taken 1557.5 hours, or nearly 65 days without interruption. In light of the time frame of the present research project, such a qualitative analysis was not practically feasible.

It emerged that the most effective way of analyzing the Swiss Federal Tribunal's case law was through an automated process. This process was conducted with the help of IT specialist Nicolas Hubacher.

This appendix provides details about the methodology used in the study. The first section addresses the way the keywords were defined (I.). The second one describes how the automatic ruling analysis was carried out (II.). The IT-related explanations in this appendix have been provided by Nicolas Hubacher.

I. Defining the Keywords

In the context of an empirical study like the present one, it is essential to clearly define the criteria that determine the relevance of a case.

For the purposes of this study, a case pertaining to international law:

- contains at least one keyword that refers to international law (or to related terms), be it:
    - a keyword related to public international law (e.g., "Völkerrecht", "droit international public");
    - a keyword related to private international law (e.g., "internationales Privatrecht", "droit international privé");
    - a keyword mentioning international law in general (e.g., "internationales Recht");

or

- contains at least one keyword that refers to a source of international law, be it:
    - treaty law (e.g., "Staatsvertrag", "traité international", etc.);
    - customary international law (e.g., "internationales Gewohnheitsrecht", "droit international coutumier", etc.);

- general principles of international law (e.g., "principes généraux du droit international").

The keywords were defined in two steps. First, it was necessary to establish a list of keywords from scratch, as there is no established taxonomy of international law keywords that could have been used for such a search and that would fit the (multilingual) language used in the Swiss case law. The trilingual thesaurus Jurivoc developed by the Swiss Federal Tribunal[1] was too detailed for the purposes of this study, and it was easier to define the keywords independently. The list which was established contained keywords which either clearly indicated that the Court had applied international law (so-called precise keywords, e.g. "international law"), or which could indicate an application of international law, but were ambiguous (so-called broad keywords, e.g. "convention", which designate a treaty, but also an agreement under domestic law).

In a second step, these precise and broad keywords were used to define so-called regular expressions. Regular expressions (or regex[2]) are used to define search patterns describing a certain string format (i.e., the format of a series of signs). These search patterns make it possible to extract all text passages that match the defined format. Regex are extracted by using wildcards. Wildcards are comparable to jokers: they consist in symbols that represent one or more type(s) of characters (e.g. numbers, word characters, numbers *and* word characters, space, etc.).[3] Through this approach, additional keywords were identified. These keywords either clearly pertained to international law (e.g. "Doppelbesteuerungsabkommen", which was found based on the broad keyword "Abkommen") or were found after performing a qualitative check of the relevant ruling(s) to verify whether the case was indeed related to international law. These additional keywords were added to the list of precise keywords. When the qualitative check showed that only part of the search results were indeed related to international law (e.g. 2 out of 3 cases), only the relevant occurrences were counted.

A comprehensive qualitative check was performed only for rulings pertaining to customary international law and general principles of international law, given that there

---

1 Thesaurus Jurivoc © 1999 - 2012 Swiss Federal Tribunal. Jurivoc can be downloaded at <http://www.bger.ch/fr/index/juridiction/jurisdiction-inherit-template/jurisdiction-jurivoc-home/jurisdiction-jurivoc-upload.htm>. The Swiss Federal Tribunal's terms and conditions (including in terms of copyright) apply.

2 <http://www.regular-expressions.info/>.

3 The wildcard '.', for instance, matches any character, '\w' matches a word character, '\d' matches a digit, '[ay-]' matches the letter 'a' or 'y' or the symbol '-', etc. Furthermore, quantifiers specify how often a preceding element has to occur in order to be found: zero or once ('?'), zero or more ('*'), one or more ('+'), three ('{3}'), etc.

were relatively few of them (less than fifty). The large number of rulings under scrutiny made it practically impossible to conduct a comprehensive qualitative check, and the decision to perform qualitative checks with regards to rulings on treaty law and on international law in general involves some discretion. For the sake of transparency, the final list of the so-called precise keywords and broad keywords that were used is included in the code repository of the study.[4] A detailed list of the criteria used for moving keywords pertaining to treaties from the broad to the precise keywords list is provided in Appendix II. Finally, an attempt was made to shed light on the share of decisions that mention international law "in passing". Such decisions are often excluded by researchers in studies like the present one. Because no comprehensive qualitative check was performed, these decisions were not excluded. However, a rough estimate of their practical importance was obtained by establishing a table with so-called "weak decisions", i.e., decisions that did not mention any SR number and that only contained one of the listed keywords (with one or more occurrences). The conjunction of these two features was deemed an indication that international law was not at the centre of the Court's reasoning. The table contains 492 decisions.

Besides allowing us to identify additional "precise keywords", the use of regex helped eliminate results deemed either ambiguous or clearly irrelevant. These results were:

- results that could refer to a domestic legal concept and/or for which the international law dimension was not clear (e.g. "droit coutumier", "des gens", "droit des gens", "gewohnheitsrechtlich");
- results where the relevant keyword was followed by a Roman or Arab figure (e.g. "droit international xxxvi") or by "in", which suggested that the keyword appeared in the title of a publication on international law relied on by the Court, and not necessarily in the context of an international legal issue.

Other search results were not removed, namely:

- results that did not match any of the languages of the search or might be spelling mistakes, but still pertained to international law (e.g. "international recht", which appeared in the title of a Dutch publication cited by the Court);
- results that consisted in a keyword related to international law followed by a single letter (e.g. "à", "n", "l", which were often abbreviated pronouns or negations, e.g. "n'" + verb", "l'" + verb or pronoun, etc.).

Not all spelling mistakes or keywords in a foreign language can be detected through an automated search. Indeed, due to the way regular expressions designed, text passages

4 <http://github.com/hubifant/fedsupcourt>.

are only found if they contain the entire keyword (i.e., all parts of the keywords). "International recht", for instance, could be detected thanks to the use of wildcards that allowed to capture various grammatical forms (on this point, see *infra*, II.B.).

After several iterations, the remaining search results (composed of nouns, adjectives, adverbs, pronouns, and prepositions) fell into one or more of the following categories:

- references to the notion of international law (e.g., "Völkerrecht", "internationales Privatrecht", "internationales Recht");
- references to a specific international legal act (e.g., "internationale Menschenrechtspakte", which refers to the ICCPR and ICESCR);
- references to a source of international law (e.g., "droit international conventionnel", "Völkergewohnheitsrecht");
- references to a substantive area of international law (e.g., "internationales Steuerrecht", "Völkerstrafrecht");
- references to a concept of international law (e.g., "Völkerrechtssubjekt", "internationale Rechtshängigkeit");
- references to the (in)compatibility of national law with international law (e.g., "völkerrechtskonform", "völkerrechtswidrig").

To determine whether the automatic analysis was reliable, a random[5] subset of 250 cases was conded manually and compared with the automated search results. The manual coding led to the result that 26 cases pertained to international law (or, in other words, that there were 26 positive samples), while 224 did not (so-called negative samples). 25 out of the 26 positive samples (96.15%) were true positives (in the sense that they had also been marked as relevant by the automated search), while 1 sample (3.85%) was a false positive (i.e., it had been falsely marked as relevant by the automated search). Out of the remaining 224 negative samples, 219 (97.77%) were true negatives, meaning that they had also been marked as irrelevant by the automated search). 2.23% were false negatives, as they had falsely been marked as irrelevant by the automated search.

When manually checking the false positives, it emerged that based on our criteria, the decisions were actually relevant (i.e., they were true positives) and had hence been rightly detected by the automated search. However, they all mentioned international law in passing, which made them easy to miss when doing the manual coding. Similarly, the false negative was in fact a true negative. The mismatch was due to an error in the manual coding. Without these mistakes in the manual coding, the rate of agreement would have reached 100% (instead of a rate of agreement of 97.7%, based on 244 cor-

[5] The random sample was selected by taking every 50th ruling issued since 1954.

rectly classified judgments versus 6 wrongly classified ones). It could hence be concluded that the automated search results were reliable. Admittedly, based on the criteria used, it is possible that some decisions are included in the count even if they are not connected to international law in an obvious way. However, given the high rates of agreement initially achieved, the percentage of decisions affected is likely to be low (less than 5%).

Table 1: Result of the Manual Coding of a Random Subset of 250 Cases

	Positive Samples (Rulings Manually Classified as Relevant)	**Negative Samples (Rulings Manually Classified as Irrelevant)**	**Comments**
	26	224	
True samples and rate of agreement (i.e., number of either positive or negative samples automatically classified as relevant)	25 (96.15%)	219 (97.77%)	Error occurred in the manual coding
False samples and rate of agreement (i.e., number of either positive or negative samples automatically classified as irrelevant)	1 (3.85%)	5 (2.23%)	Error occurred in the manual coding

II. The Automated Ruling Analysis

To analyze the rulings through an automated process, the *python* programming language was used.[6] The search was conducted in three steps, namely web-scraping (A.), keyword extraction (B.), and unit testing (C.).

6 <http://www.python.org/>.

A. Web-Scraping

This subsection explains how the rulings were downloaded and how the database was scraped (1.). It also provides information on how cases mentioning the SR number of a given treaty were found (2.). Finally, it clarifies how the rulings were saved in a database (3.).

1. Downloading the Rulings and Scraping the Database

In a first step, it was necessary to find a way of downloading the rulings from the website of the Swiss Federal Court. The Swiss Federal Tribunal's website gives access to two main databases: a database containing decisions from 1954 onwards published in the official compendium (hereinafter "the 1954 database", which is the object of the search), and a database with both published and unpublished decisions dating from 2000 onwards (hereinafter "the 2000 database").

The 1954 database can be accessed *inter alia* through an index of the rulings sorted by year. Every year has a given number (starting with 1 for the year 1875), which is also the first number that appears in the official citation of a ruling (for example, BGE 80 x y designates a ruling published in the 80th year after 1875, in 1954).

The case law is divided into different volumes: 4 volumes from 1954 to 1994 (with volume I split into Ia and Ib from 1972 onwards), and 5 volumes from 1995 onwards. Every volume represents a specific subject matter and is assigned a given Roman numeral.[7] This classification provides insights into the main subject matter of the cases in which the Court has referred to international law.

7 <http://relevancy.bger.ch/php/clir/http/help_de.html>.

Table 2: Classification of Rulings Published in the Official Compendium Based on the Main Subject Matter of the Case

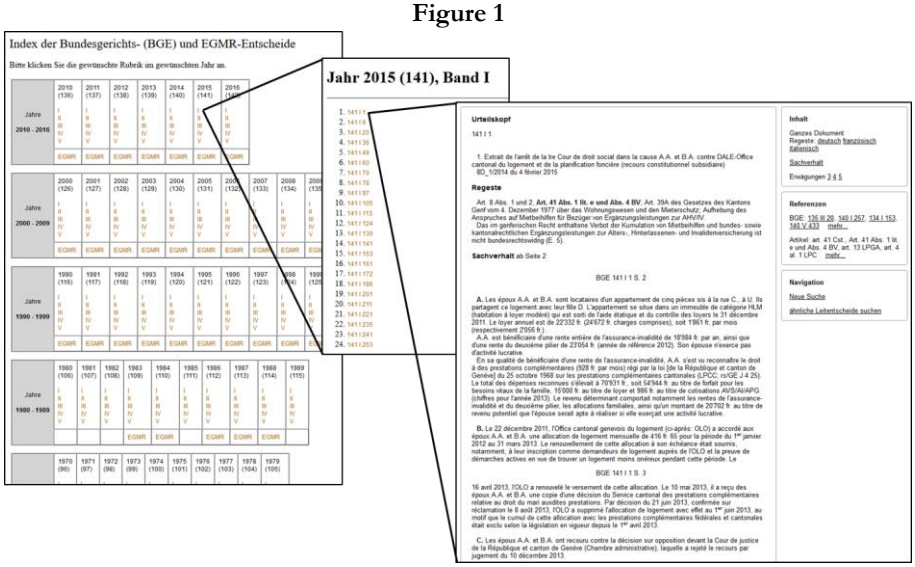
	1954-1971	1972-1994	From 1995
Vol	**Subject Matter**	**Subject Matter**	**Subject Matter**
Ia	-	Constitutional law	-
Ib	-	Administrative law and international public law	-
I	Constitutional law, administrative law and international public law	-	Constitutional law
II	Private law	Private law	Administrative law and international public law
III	Debt recovery and bankruptcy	Debt recovery and bankruptcy	Private law and debt recovery and bankruptcy
IV	Criminal law and criminal enforcement law	Criminal law and criminal enforcement law	Criminal law and criminal enforcement law
V	Social insurance law	Social insurance law	Social insurance law

Every year of case law is represented by a link. This link leads to a webpage with a list of the rulings dating from that year published in the compendium. Every entry of this list is, again, represented by a link leading to the page of a given ruling.

This index allows scraping the database: based on the top level of this hierarchical index,[8] the links can automatically be followed in order to access the complete set of published rulings (Figure 1).

[8] <http://relevancy.bger.ch/cgi-bin/IndexCGI?lang=de>.

Figure 1



In order to scrape the database, the python library *Scrapy* was used.[9] *Scrapy* is a convenient choice, as it provides tools to request websites and to extract information from their source code.

Web documents are written in the Hypertext Markup Language (HTML[10]), which can be displayed by web browsers such as Firefox, Google Chrome, Edge, etc. The nature of HTML causes the web documents to be systematically structured: every passage of the text on a website is marked by a tag (e.g. "h1", "div", "a", etc.).

The following HTML snippet shows a typical example from a ruling website:

```
<div class="content">
   <div class=”big bold”>Urteilskopf</div>
   <div class=”paraatf”>
      1. Auszug aus dem Urteil der I. sozialrechtlichen Abteilung i.S.
      A. gegen Gemeinde B. (Beschwerde in öffentlich-rechtlichen Ange-
      legenheiten)
   </div>
   <div id=“regeste“ lang=“de“>
```

9 <http://scrapy.org/>.

10 <http://www.w3schools.com/html/>.

```
      (...)
   </div>
</div>
```

There is an outer "div" element to which the class "content" is assigned. This element contains three further "div" elements. The first two elements represent text: the title "Urteilskopf" and the appertaining paragraph. The ID "Regeste" is assigned to the third inner "div" element, and we can read from the attribute "lang" that it is written in German. The content of this element is left out here.

Such a HTML tag can contain metainformation which is not displayed by web browsers. It can for instance be used to correctly represent content (the "class" assigned to an element; for every class, a set of displaying rules can be defined). It can also be relied on to specify the language in which the text is written. This nested structure can be exploited for the purposes of extracting information. It helps a computer navigate in a document. This task is trivial for humans, who can for instance instantly see which part of a ruling contains the core issue. A computer can find this paragraph by extracting the "div" tag to which the ID "Regeste" is assigned.

After having extracted the text of a ruling page, metadata (e.g., the date of the ruling, the parties involved, the division of the court, etc.) were extracted from the text. Extracting metadata allows sorting and grouping the rulings in order to gain interesting insights.

Figure 2: Beginning of the Source Code of Ruling BGE 142 I 1[11]

```
<!DOCTYPE html PUBLIC "-//W3C//DTD XHTML 1.0 Transitional//EN" "http://www.w3.org/TR/xhtml1/DTD/xhtml1-transitional.dtd">
<html lang="de">
<head></head>
<body onkeypress="keyPressed(event);">
<div id="ns4_info" class="warning_msg"></div>
<div class="middle"></div>
<div class="main">
<div class="left"></div>
<div class="middle">
<div id="highlight_content" class="box">
<div class="box_top_line"></div>
<div class="box_top_2ndline"></div>
<div class="content">
<a name="idp345504"></a>
<div class="big bold">Urteilskopf</div>
<br>
142 I 1
<br>
<br>
<br>
<div class="paraatf">
1. Auszug aus dem Urteil der I. sozialrechtlichen Abteilung i.S. A. gegen Gemeinde B. (Beschwerde in öffentlich-rechtlichen Angelegenheiten)
</div>
<div class="paraatf">
8C_455/2015 vom 8. März 2016
<div>
<div></div>
</div>
</div>
<a name="idp347136"></a>
<br>
<div id="regeste" lang="de">
<div class="big bold">Regeste a</div>
<br>
<div class="paraatf">
```

2. Finding Cases Mentioning the SR Number of a Treaty

Web-scraping was also used to find cases in which treaties had been mentioned via their number in the Classified Compilation of Federal Law (the so-called "SR number").

A list of treaties to which Switzerland is a party, including these treaties' SR number, can be found on the website of the Swiss federal authorities.[12] The list of legal acts is divided into nine main categories and hundreds of subcategories and subsubcategories. Every legal act is thus hierarchically indexed.

---

[11] This picture is a screenshot of the Swiss Federal Tribunal's official website. See <http://relevancy.bger.ch/php/clir/http/index.php?lang=de&zoom=&type=show_document&highlight_docid=atf%3A%2F%2F142-I-1%3Ade>.

[12] <http://www.admin.ch/opc/de/classified-compilation/international.html>.

The legal act "0.192.030 Satzung des Europarates vom 5. Mai 1949", for instance, is categorized on the 6th level of the hierarchy:

0.1 Internationales Recht im Allgemeinen

0.19 Diplomatische und konsularische Beziehungen. Sondermissionen. Internationale Organisationen. Regelung von Streitigkeiten. Weitergeltung von Verträgen

0.192 Internationale Organisationen.

0.192.0 Satzungen

0.192.03 Europarat

0.192.030 Satzung des Europarates vom 5. Mai 1949

3. Saving the Rulings in a Database

To be able to analyze the rulings offline, it was necessary to save them on a computer. In order to provide adequate access to the scraped data (i.e., to select a subset of rulings based on the extracted metadata, as for instance "give me all the rulings from 1988"), each ruling was saved in a MongoDB database.[13]

MongoDB is appropriate for our task because it is a document-oriented non-relational database. This means that contrary to traditional relational databases such as MySQL or Oracle SQL, which store data in tabular form,[14] MongoDB does not require predefining any database schema (the column names in a relational database). Instead, the data are saved document-by-document (in our case, ruling by ruling). The type of information a document contains can vary from one document to the other.

This is an example of a ruling document as saved in the MongoDB database:

```
{
    "_id" : "137 III 529",
    "department"                          :                          {
        "tag"              :               "Private               Law",
        "extracted_department"   :   "II.   zivilrechtlichen   Abteilung"
    },
```

[13] <http://www.mongodb.com/>.

[14] For an example, see <http://i.ytimg.com/vi/fnbLMcd0FGQ/maxresdefault.jpg>.

```
    "language"                          :                          "de",
    "art_refs"                            :                            [
        "Art.          8          Abs.          1          BG-KKE"
    ],
    "dossier_number"                  :                  "5A_674/2011",
    "type_of_proceeding"     :     "Beschwerde     in     Zivilsachen",
    "ruling_id"                           :                           {
        "volume"                        :                        "III",
        "bge_nb"                         :                         137,
        "ruling_nb"                        :                        529
    },
    "involved_parties"                       :                       {
        "claimant"                       :                       "X.",
        "defendant"                        :                        "Y."
    },
    "url"                                                            :
"http://relevancy.bger.ch/php/clir/http/index.php?lang=de&zoom=&type=s
how_document&highlight_docid=atf%3A%2F%2F137-III-529%3Ade"
},
    "date"             :             ISODate("2011-10-31T00:00:00Z"),
    "title_of_judgement" : "77\\. Auszug aus dem Urteil der II. zivil-
rechtlichen Abteilung i.S. X. gegen Y. (Beschwerde in Zivilsa-
chen)\n\n\n5A_674/2011       vom       31.       Oktober       2011",
    "core_issue" : "Regeste\n  \n\n\n\nArt. 11 Abs. 2 HKÜ; Art. 8 Abs.
1 BG-KKE; Kindesrückführung; Beschleunigungsgebot. \n\nOrganisation
des Verfahrens vor dem Hintergrund der sechswöchigen Frist, namentlich
mit Blick auf die Vermittlungsverhandlung bzw. Mediation (E. 2.2).",
    "statement_of_affairs" : "A.  Y. und X. sind die Eltern der 2000
geborenen Z. Die ersten Lebensjahre verbrachte das Kind mit seinen
Eltern in der Schweiz.\nDie Ehe der Parteien wurde am 16. November
2006 in Sofia geschieden, wobei das Sorgerecht der Mutter übertragen
wurde. Die Tochter lebte im Anschluss zusammen mit ihrer Mutter in
Bulgarien.\nDer Vater blieb weiterhin in der Schweiz. Wie in den ver-
gangenen Jahren hatten die Eltern auch für die Sommerferien 2010 ver-
einbart, dass Z. diese bei ihrem Vater in Bern verbringen und Anfang
August 2010 wieder nach Bulgarien zurückkehren würde. Indes behielt
der Vater sie bei sich in Bern zurück.\n\nB.  Am 9. November 2010
stellte die Mutter (Y.) beim Obergericht des Kantons Bern einen Antrag
auf Rückführung von Z. nach Bulgarien.\nMit Entscheid vom 20. Septem-
ber 2011 ordnete das Obergericht die Rückführung von Z. an und regelte
```

die betreffenden Modalitäten.\n\nC. Gegen diesen Entscheid hat X. am 29. September 2011 Beschwerde in Zivilsachen erhoben, welche das Bundesgericht abweist, soweit es darauf eintritt.\n\n_(Zusammenfassung)_",

"paragraph" : "Aus den Erwägungen:\n\n2\\. \n\n\n2.2 \n(...) Im Zusammenhang mit der vom Vater erwähnten 6-Wochen-Frist gemäss Art. 11 Abs. 2 des Haager Übereinkommens vom 25. Oktober 1980 über die zivilrechtlichen Aspekte internationaler Kindsentführung (HKÜ; SR 0.211.230.02) wird allerdings deutlich, dass dem von ihm angerufenen Beschleunigungsgebot bei Kindesrückführungen eine besondere Bedeutung zukommt. Zwar zeigt sich in der Praxis, dass die 6-Wochen-Frist im erstinstanzlichen Verfahren oft schwer einzuhalten ist, namentlich vor dem Hintergrund der Gehörsgewährung, und gemäss Konventionswortlaut kommt ihr denn auch explizit nur Richtliniencharakter zu. Indes ergibt sich aus dieser sowie aus den weiteren auf ein rasches Handeln zielenden Normen (Art. 1 lit a HKÜ: sofortige Rückgabe; Art. 2 HKÜ: schnellstmögliche Verfahren; Art. 11 Abs. 1 HKÜ: gebotene Eile), dass die notwendigen Instruktionsmassnahmen mit Vorteil in einer umgehend erlassenen Instruktionsverfügung zu kondensieren sind (nach Möglichkeit bereits verbunden mit der Ansetzung einer Vermittlungsverhandlung oder einer Schlussverhandlung für den Fall des Scheiterns einer Mediation, soweit eine solche Verhandlung angebracht erscheint) und insbesondere eine gestützt auf Art. 8 Abs. 1 des Bundesgesetzes vom 21. Dezember 2007 über internationale Kindesentführung und die Haager Übereinkommen zum Schutz von Kindern und Erwachsenen (BG-KKE; SR 211.222.32) gegebenenfalls angeordnete Mediation nicht quasi ausserhalb der vom HKÜ vorgegebenen Richtlinienfrist stattfinden kann, ist sie doch Teil des erstinstanzlichen Rückführungsverfahrens. Auch bei Anordnung einer solchen ist mithin auf äusserste Speditivität zu achten und das Verfahren strikt in richterlicher Hand zu behalten. Eine allfällige Mediation ist deshalb in strukturierter Weise und, wie sich bereits aus der Botschaft zum BG-KKE ergibt (BBl 2007 2625 Ziff. 6.7), geknüpft an richterlich vorgegebene Fristen anzuordnen (beispielsweise drei Sitzungen innerhalb einer Woche oder Sitzungen an zwei aufeinanderfolgenden Wochenenden und begründete Benachrichtigung des Rückführungsgerichtes bzw. begründetes Ersuchen um Fristverlängerung, falls noch kein Resultat erzielt worden, aber ein solches in absehbarer Zeit zu erwarten ist und die Mediation deshalb weitergeführt werden sollte). Ferner ist zu beachten, dass sich der Zweck einer Mediation darauf beschränkt, die freiwillige Rückführung des Kin-

des zu erreichen oder eine gütliche Regelung der Angelegenheit herbeizuführen (Art. 8 Abs. 1 BG-KKE), sie aber insbesondere nicht der Abklärung von irgendwelchen Sachverhaltselementen dient. (...)",
"international_treaties" : {
"clear" : {
"keywords" : [
{
"keyword" : "Haager Übereinkommens",
"count" : 1
},
{
"keyword" : "Haager Übereinkommen",
"count" : 1
}
],
"contexts" : [
{
"keyword" : "Haager Übereinkommens",
"sentence" : "(...) Im Zusammenhang mit der vom Vater erwähnten 6-Wochen-Frist gemäss Art. 11 Abs. 2 des Haager Übereinkommens vom 25.",
"chapter" : "paragraph"
},
{
"keyword" : "Haager Übereinkommen",
"sentence" : "Dezember 2007 über internationale Kindesentführung und die Haager Übereinkommen zum Schutz von Kindern und Erwachsenen (BG-KKE; SR 211.222.32) gegebenenfalls angeordnete Mediation nicht quasi ausserhalb der vom HKÜ vorgegebenen Richtlinienfrist stattfinden kann, ist sie doch Teil des erstinstanzlichen Rückführungsverfahrens.",
"chapter" : "paragraph"
}
]
}
},
"extracted_laws" : [
{
"hierarchy_level" : 2,
"law" : "0.211.230.02"

```
        }
    ],
    "extracted_categories"                    :                    [
        {
            "hierarchy_level"                 :                    0,
            "category"                        :                    "0.2"
        },
        {
            "hierarchy_level"                 :                    1,
            "category"                        :                    "0.21"
        }
    ]
```


B. Keyword Extraction

As previously mentioned, two categories of keywords (precise versus broad keywords) were used (*supra*, I.). If a precise keyword (such as "völkerrechtliches Gewohnheitsrecht") is detected in the text of a ruling, the ruling is highly likely to pertain to international law and hence to be relevant for the purposes of the present study. By contrast, the occurrence of broad keywords (e.g. "Abkommen") does not allow concluding that a case mentions international law.

Because a computer only detects perfect matches, a major challenge of keyword extraction is to find all possible variations of a keyword (e.g., grammatical forms, typos, etc.).

One way of tackling this problem is to create a list containing all these variations. This approach is rather fastidious and imprecise, as the list will necessarily be incomplete and will not include typos. As previously mentioned (*supra*, I.), a list was used at the beginning of the search in order to create and test the correct regex search terms. Regex later helped finding additional keywords that were not on this original list.

Another possible approach to address this difficulty is to use a natural language processing (NLP) tool such as *alchemyAPI*,[15] which extracts keywords or concepts automatically and represents them in a normalized form. This dispenses from searching the different grammatical forms of a keyword. However, NLP tools are not tailored to the specificities of legal language. They are hence unlikely to extract all keywords which are of interest. Moreover, they may extract keywords in an incorrect or incomplete way, or wrongly deem some keywords irrelevant. Another consideration is that in the present

15 <http://www.alchemyapi.com/>.

case, the rulings to be analyzed are written in German, French, Italian, or even Romansh (although no keywords Romansh were used). The NLP tool must therefore work with multiple languages. Alternatively, one must be able to use multiple tools specialized in different languages. In short, finding an NLP tool that is appropriate for the present task was practically difficult. No NLP tool that extracts the keywords automatically was used; instead, we implemented the keyword extraction functionality ourselves.

Eventually, the keywords were extracted through regex and wildcards (*supra*, I.). This dispensed from searching for all grammatical forms of a precise keyword. For instance, the regex

```
'(?:international)\w*[\s\-
]?(?:abkommen|pakt|übereinkommen|vertr[aä]g)\w*'
```

matches any possible combination of variations of the word "international" (or "internationales", etc.) and variations of the words "Abkommen", "Pakt", "Übereinkommen", or "Vertrag" (or "Verträge"), e.g., "internationalvertraglich", "internationalen Übereinkommens", "internationales Abkommen", etc.

Regex were also used to match several words preceding and/or following a "broad" keyword. In doing so, we hoped to extract enough information about a "broad" keyword to be able to judge whether it was relevant or not.[16]

After extracting the keywords and SR numbers for every ruling and saving them in the database, the entire ruling collection was analyzed

In a first step, the global list of "precise" keywords was improved, i.e., the list of all "precise" keyword extracted from any ruling in the database. Keywords which did not clearly indicate that international law had been applied were removed from the list. Keywords from the list of broad keywords which were deemed good indicators for the application of international law (if necessary based on a manual check) were moved to the list of precise keywords. Moving a keyword in this way requires adapting the regex. After having settled on a final keyword extraction regex and having applied it to the entire ruling database, we could easily classify rulings as relevant or not. If at least one precise keyword is extracted, the ruling is relevant; if not, it is irrelevant.

---

16 For instance, by extracting "convention relative à la double imposition" and "convention contractée par abus", it is possible to conclude that the former keyword is relevant, while the latter is not.

Finally, the statistics were generated by querying the MongoDB database. It is for instance possible to query all rulings for which a list of extracted "precise" keywords referring to "international treaties" exists:

```
db.rulings.find({
        "international_treaties.precise": {
                $exists: 1
        }
})
```

Through more complex queries, it is possible to group the rulings, e.g. by date or by subject matter (based on the volume in which a decision is published), and to count all relevant rulings contained in one of the specified groups.

C. Unit Testing

To make sure that the program works properly, its most important parts, such as the keyword extraction, were subjected to unit tests.

Unit testing consists in checking the functionality of small components (modules) of the source code by inputting so-called "dummy data". Dummy data is data that simulate real data, but for which the desired output of the tested module is known. This allows detecting bugs and locating them easily. A substantial amount of time can be saved by testing the program module by module (and not the entire program at once), as the bug must be in the tested module.