

# An Analysis of Three Legal Citation Networks Derived from Austrian Supreme Court Decisions

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**Abstract:** In this paper, we present a case study on the structural properties of three citations networks derived from Austrian Supreme Court decisions. In particular, we analyzed 250,984 Supreme Court decisions ranging from 1922 to 2017. As part of our case study, we analyzed the degree distributions, the structural properties of prominent court decisions, as well as changes in the frequency of legal citations over time.

## 1 INTRODUCTION

Different studies analyze the structure of citation networks derived from court decisions. Most of those existing studies focused on common law court decisions (esp. in the US) from legal systems where "case law" is significantly more important than in the legal tradition of continental Europe<sup>1</sup>. In this study, we investigate the citation network formed by the Austrian civil law Supreme Court (i.e. from a legal system without a case law tradition).

What sets this study apart from similar investigations is the large number of decisions available for analysis (250,984) as well as the extensive time range (from 1922 to 2017) that was considered for our analysis. Due to the vast number of court decisions, the network generation procedure is fully automated and does not rely on a few handpicked samples.

In Austria, Supreme Court decisions can either reference/cite another court decision or a so called legal proposition. Legal propositions are documents which aggregate the major points of court decisions that are similar in content. This leads to the ques-

tion of potential differences that arise between the citation networks that can be derived from these two types of citations. Moreover, since legal propositions must also refer to the court decisions they aggregate, a third citation network can be constructed from the outgoing links of legal propositions.

For this study, we investigated the following questions for the three citation networks mentioned above:

- Does the degree distribution of a network follow a power-law distribution that often emerges in citation networks?
- Do the most prominent nodes of the network, as established by in-degree centrality and Kleinberg's hub and authority score (Kleinberg, 1999), also hold legal significance?
- How do the citation networks evolve over time? Which nodes receive the highest number of citations? How does the number of citations vary between time periods? How do structural properties of the networks develop over time?

## 2 RELATED WORK

The structural properties of citation networks derived from court decisions have been studied in several legal domains, most prominently in the US legal system. For example, (Chandler, 2005) studied the citation network of the United States Supreme Court. Moreover, (Fowler and Jeon, 2008) and (Fowler et al.,

<sup>1</sup>In a legal system based on "case law", the law is actively developed through court decisions and courts base their decisions on previous judicial verdicts. In this context, the principle of "stare decisis" demands that judges must consider previous cases for their own decision. This is fundamentally different from civil law jurisdiction as found throughout continental Europe where case law and case citation are of lesser importance, and legislation remains the ultimate source of the law.

2007) identified the most central decisions of the United States Supreme Court. They point out the value of Kleinberg’s hub and authority score for determining the most relevant cases in the citation network. It allows to identify key cases that are influential (authority score) and well founded in law (hub score). Therefore, Kleinberg’s score is assumed to be superior for analyzing networks of court decisions in comparison to other traditional measures of network centrality. In another study (Smith, 2007), the citation network resulting from US Supreme Court decisions was found to follow a power-law degree distribution.

(Agnoloni and Pagallo, 2015) studied the citation network of the Italian Constitutional Court where they also found a power-law degree distribution and confirm the finding that high hub and authority scores are often correlated to the most debated cases in Italian legal journals. Similar studies exist for other legal systems. For example, (Winkels et al., 2011) studied the citation network of the Dutch Supreme Court, (Mazzega et al., 2009) investigate citations in the French legal system, (Tarissan et al., 2016) and (Lettieri et al., 2016) decisions of the European Union Court of Justice. In addition, (Gelter and Siems, 2012) investigated cross-citations between ten of Europe’s highest courts.

(Koniaris et al., 2017) analyze EU legislation and create a multi-relational network encompassing the hierarchy between different sources of primary and secondary EU law and different types of relationships between legal documents. They also perform a resilience test in order to predict the behavior of the network under malfunctions when legal documents or connections between them are severed, simulating that existing law can be amended or removed.

### 3 DATA EXTRACTION AND NETWORK DERIVATION

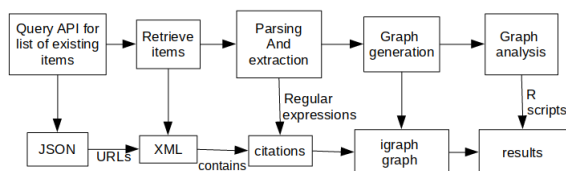


Figure 1: Data extraction and analysis.

Figure 1 shows an overview of the data extraction and analysis procedure that we applied for our case study. In particular, Austrian Supreme Court decisions are accessible via a publicly available database called "legal information system" (German: RechtsInforma-

tionsSystem, abbreviated RIS)<sup>2</sup>. For automated data retrieval, the court decisions are part of the "Open Government Data" initiative and accessible via a variety of interfaces, supporting formats such as JSON, XML and HTML.

For our case study, we used the JSON-based interface which returns a list of all available decisions for a given time range. For each result, this data also contains links to the full text of the decisions in XML format. This way, we retrieved all Supreme Court decisions from 1922 to the end of 2017, resulting in a total of 250,984 files. Each file represents a distinct decision from the field of civil law or criminal law or a legal proposition which aggregates and summarizes a major point of two or more decisions.

The XML files retrieved in the previous step were used for building and analyzing directed graphs of citations using the R language and the igraph package<sup>3</sup>. For each XML file with at least one citation, a node is added to the citation graph. For every outgoing citation an edge is created to the node that is being cited. In addition, the respective decision dates are stored as node attributes. The data retrieved from the RIS allow to distinguish between decisions and legal propositions, but do not allow to infer precisely to which legal matter the file belongs. However, not all decisions are available as full text. This especially applies to court decisions which were published before the RIS became available. Thus, if no XML file for a court decision exists, the decision can only be cited, but cannot have outgoing links and attributes in our network. In particular, we derived the following networks from the data:

- *Network A*: court decisions citing other court decisions by their unique reference number;
- *Network B*: decisions citing legal propositions by their unique identifier;
- *Network C*: legal propositions citing decisions by their reference number.

**Network A (Reference Number Citing Reference Number):** every Supreme Court decision has at least one unique reference number (German: Geschäftszahl, abbreviated GZ). A reference number encodes basic information about the decision in a systematic manner. For example, the reference number *3 Ob 646/79* informs us about the deciding senate (e.g. 3), about the deciding court (e.g. O for Supreme Court), the type of legal matter (e.g. b for civil law), an incremental consecutive numbering (e.g. 646) and the year in which the case was received

<sup>2</sup><https://www.ris.bka.gv.at/>

<sup>3</sup>[igraph.org](http://igraph.org)

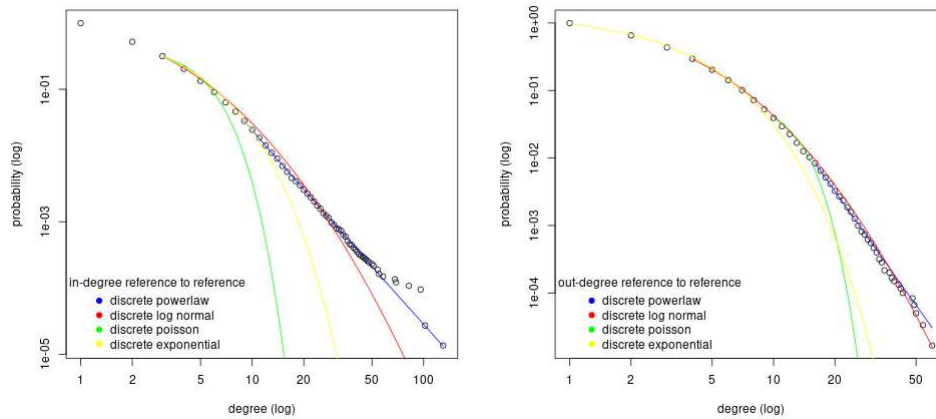


Figure 2: in-degree (a) and out-degree (b) distribution of network A.

by the Supreme Court (e.g. 1979). Note that this is not necessarily the same year as the decision date.

In our data-set, 123,222 of the 250,984 XML documents have a reference number and thus can be classified as court decisions. However, only 60,758 of these decisions have outgoing citations to other decisions. Based on this data, we derived a directed graph consisting of 96,444 nodes and 188,024 edges representing citations between the nodes. For 16,122 of the nodes (16.7%) that have at least one incoming edge (i.e. they are cited at least once) the RIS does not provide a corresponding XML file. Thus, the corresponding nodes can only have incoming citations (incoming edges) and no attributes.

The largest connected component in Network A consists of 86,247 out of 96,444 nodes (89%). The network is not fragmented into large disconnected components, which indicates that citations occur between different legal areas such as criminal law and civil law.

**Network B (Reference Number Citing Legal Proposition):** So-called "legal propositions" (German: *Rechtssätze*, RS) are artificially created hub nodes pointing to several court decisions that are similar in content. These documents are created and maintained by the office of records (German: *Evidenzbüro*) of the Austrian Supreme Court<sup>4</sup> and made available in the RIS. They are updated and amended if new decisions appear that fit the office's similarity requirements. In our data-set, 30,242 of the nodes are RS and 41,494 nodes are court decisions referencing those RS. From those nodes, we derived a directed bipartite citation network consisting of 71,736 nodes and 167,584 edges.

<sup>4</sup><http://www.ogh.gv.at/service/evidenzbuero/>

**Network C (Legal Proposition Citing Reference Number):** Legal propositions are not only cited in court decisions, but are linking to decisions themselves. Thus, legal propositions have outgoing links to at least one decision whose content they summarize. Note, however, that legal propositions cannot point to other legal propositions.

From our data-set, we derived a bipartite network consisting of 300,480 nodes and 565,814 edges, with 176,564 nodes representing court decisions and 123,916 nodes representing legal propositions. For Network C, 76,186 (25% of all nodes) of the reference numbers that are cited by some other node are not available as XML files. In all three networks, we found two major clusters consisting of civil law decisions/propositions and criminal law decisions/propositions respectively.

## 4 STRUCTURAL PROPERTIES

In order to investigate the structural properties of the three networks, we will analyze the respective degree distributions, identify the most prominent nodes, and look at the temporal changes in the citation links.

Different studies found that citation networks derived from scientific publications often show a power-law degree distribution, see, e.g., (Price, 1965), (Silagadze, 1999) and (Redner, 1998). However, since it is not trivial to distinguish power-law distributions from other types of (heavy-tailed) distributions (Stumpf and Porter, 2012), we applied the procedure suggested by (Clauset et al., 2009) in order to determine the degree distributions of the three citation networks we derived. In particular, the procedure includes a

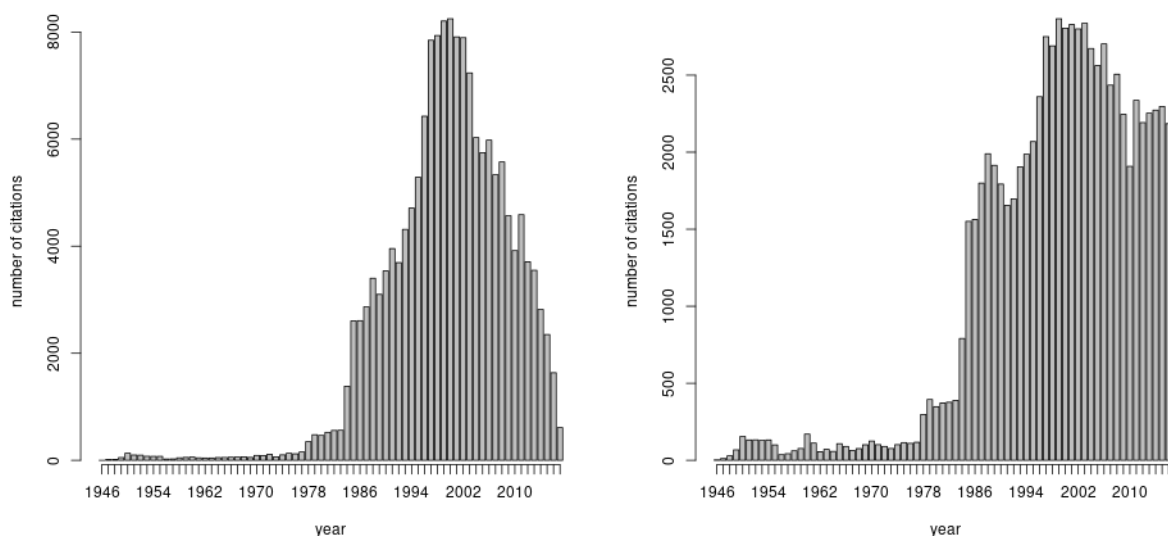


Figure 3: incoming (a) and outgoing (b) citations of network A by year.

goodness-of-fit test for different types of distributions (exponential, lognormal, Poisson, power-law), as well as a direct comparison of the different distributions via Vuong’s test (Vuong, 1989). The corresponding computations have been conducted with the *powerLaw* package (Gillespie, 2015).

#### 4.1 Network A

The goodness-of-fit test for the in-degree distribution of Network A resulted in a *p*-value of 0.215 for a discrete power-law distribution and *p*-values close to zero for all other distributions. Direct comparisons between the distributions using Vuong’s Test (Vuong, 1989) confirm these findings and show that the power-law distribution is clearly a better fit than exponential or Poisson distributions. However, a direct comparison with the lognormal distribution is indecisive. Thus, the analysis indicates that there is a good chance the true in-degree distribution has a heavy-tail. For the out-degree distribution we found similar results, with the goodness-of-fit tests resulting in *p*-values of 0.318 for a power-law distribution and 0.279 for a lognormal distribution. For the out-degree distribution, the direct comparisons slightly favored the lognormal distribution over the power-law distribution (see also Figure 2).

The decision with the highest number of incoming citations (130) is 5Ob93/97f from 1997 which is a short decision addressing an issue related to procedural law. Note that 129 of the citations are also from 1997 and only one citation is from 1999. The second highest number of incoming citations is 102 for 5Ob115/97s (right to build) which is also from 1997, followed by 5Ob190/97w (also right to build) with 96

incoming citations. Surprisingly, nodes with a high degree of incoming citations seem to receive citations only for a short period of time. Thus the in-degree of a node may not be a good indicator of long-term significance. An attempt to explain these findings could be a citation cascade triggered by a decision that affected many follow-up decisions of that time (a pattern that could be expected in procedural law). The results also underscore the lower significance of prior decisions in civil law courts compared to common law courts. Figure 3 shows a barplot for the temporal evolution of the distribution for incoming and outgoing citations in Network A.

Calculating the authority scores of the network gives very similar results. The ten nodes with the highest in-degree and the ten nodes with the highest authority score have seven nodes in common. For outgoing citations, we find that decision 2Ob215/10x (tenancy law) from 2012 has 60 outgoing citations, followed by 13Os55/13g (criminal law) with 54 outgoing citations.

The “decision date” attribute determines the date when a court decision was made. For legal propositions, it refers to the decision date of the oldest decision included in this legal proposition. Figure 3 a) shows which years are cited most often. Intuitively one could probably assume that comparatively old decisions (before 1980) had more time to gather citations and are therefore cited more often than recent decisions. However, Figure 3 a) shows that this is not the case. Instead, citations peak around a specific time period from the mid-1990s to the first half of the 2000s with a gradual increase for the early 1980s and a gradual decrease in the second half of the 2000s. The number of citations for the years after 2010 re-

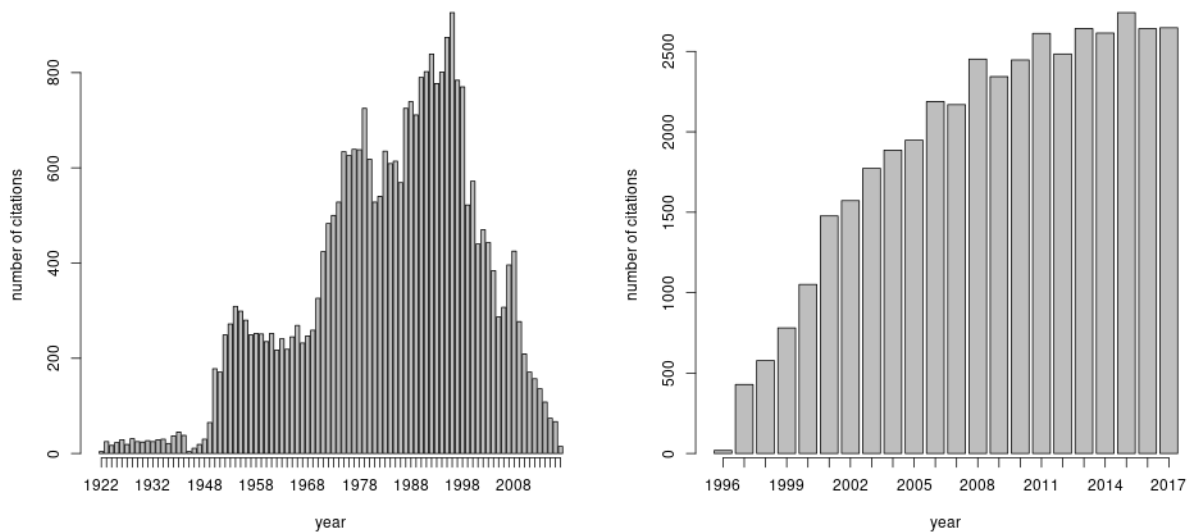


Figure 4: incoming (a) and outgoing (b) citations of network B by year.

mains high but is steeply declining, most likely because recent decisions have not been available long enough to gather a high amount of citations.

It seems that the ability of a decision to attract new citations declines with time, as they lose their relevance and are superseded by newer decisions. This interpretation seems meaningful since jurisdiction is dynamically evolving and changes that occur in legislation make citing older decisions less useful.

Figure 3 b) shows a sharp increase during the mid-1980s, followed by another spike in the late-1990s. Since then, the number of decisions remains high. The low number of older decisions can to some extent be explained by the incompleteness of the data. Older decisions might not yet have been added to the RIS database and might partially account for the 16.7% of nodes that are cited but do not have XML files (see above). Another hypothetical reason for the increasing total number of citations might be the availability of electronic systems for information retrieval. The RIS has been available since 1998 and might have facilitated the research for similar decisions.

## 4.2 Network B

With regard to the degree distribution of Network B, one would probably assume that the patterns and relations discovered for network A also apply to the citations of legal propositions. However, neither the in-degree nor out-degree distribution show evidence for heavy-tailed distributions.

In total, 30,242 nodes in our data-set represent legal propositions (42% of all nodes) and have incoming citations. The goodness-of-fit test (Clauset et al., 2009) for different distributions (exponential, Pois-

son, power-law, lognormal) showed that neither of the tested distributions provides a good fit for our data-set (the highest  $p$ -value being 0.048 for power-law distribution, while all other distributions yield  $p$ -values close to 0). A direct comparison (Clauset et al., 2009) between the power-law distribution and other distributions are inconclusive, also indicating that neither distribution provides a good fit for the data.

For the out-degree distribution of network B we analyzed 41,494 nodes. The goodness-of-fit test returned a  $p$ -value of 0.738 for a lognormal distribution followed by a  $p$ -value of 0.539 for a Poisson distribution, whereas the tests for the power-law and exponential distributions return values close to 0. However, with an  $x_{min}$  value of 48 only the far-right tail of the data provides a fit for Poisson distribution. The estimated lognormal distribution with an  $x_{min}$  of 7 clearly provides a better fit, which is also confirmed by direct comparisons.

In general, legal propositions receive a higher amount of citations than an individual court decision. The node with the highest amount of citations in Network C is RS0099810 (criminal procedural law) and has 1147 citations, followed by RS0042963 (civil procedural law) with 971 citations. Moreover, the most cited RS have remained popular over a longer period of time. For example, RS0099810 accumulated its citations from 2004 to 2017 and RS0042963 is cited from 1998 to 2017.

Nodes with a high in-degree also tend to achieve a high authority score. The top ten nodes for both scores have 4 nodes in common. However, the authority score might still not be a very useful measure for Network B since it only connects nodes of one type (RS) with nodes of another type (court de-



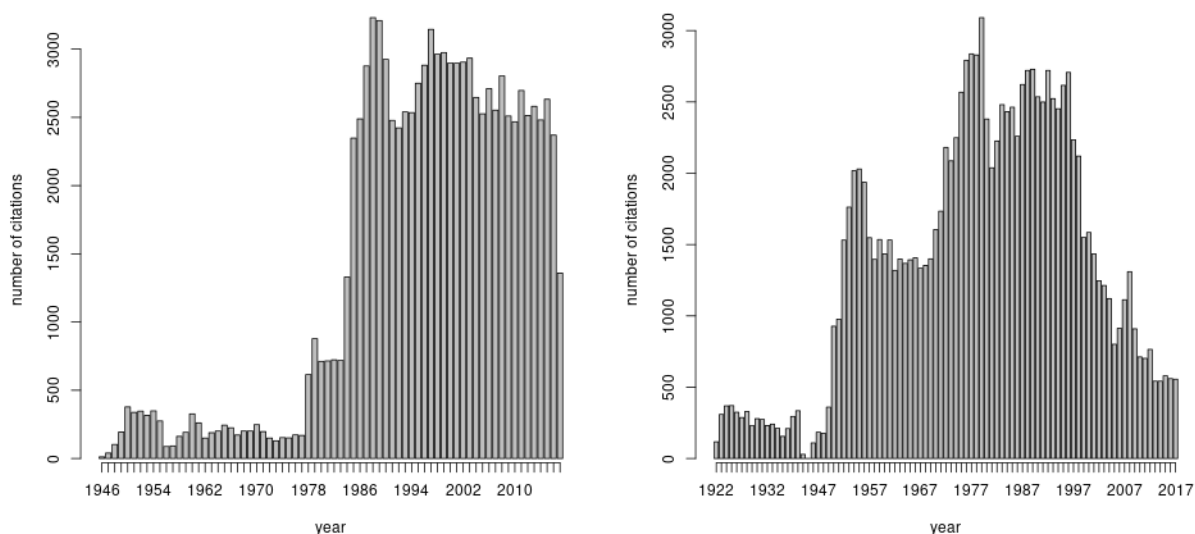


Figure 5: incoming (a) and outgoing (b) citations of network C by year.

isions). The court decision with the highest number of distinct references to RS is 13Os105/15p (criminal law) which has 73 citations followed by 13Os55/13g (criminal law) with 62 citations. The average number of outgoing citations to RS is 4.

Even though RS are only in use since 1996, the in-degree and authority score seem to be better predictors for node significance for RS than for individual court decisions. The most prominent RS nodes remain popular and continue to accumulate citations over considerably longer time periods. In contrast, the most prominent nodes for direct citations of decisions are the result of brief spikes (see above).

Figure 4 shows the distributions citations in Network B. Figure 4 a) covers the entire time period analyzed for this paper. This is because the date of an RS is the date the oldest court decision the RS refers to. The resulting plot is similar to the out-degree plot of network C in Figure 5 and has similar characteristics. Most notably, while some RS include very old decisions, many new RS refer to recent decisions only.

Figure 4 b) shows the absolute numbers for decisions citing RS per year. The plot shows a growing tendency for RS to be cited. In absolute numbers, citing individual court decisions is more common than citing RS though.

### 4.3 Network C

Legal propositions aggregate the results of similar decisions into summary statements. Those summaries are listed separately by reference number. However, these references can directly be retrieved via the corresponding tag in the respective XML file. Network C consists of 123,916 nodes (41% of all nodes) clas-

sified as legal propositions and 176,564 nodes (59% of all nodes) classified as individual court decisions.

For the in-degree distribution of incoming citations for court decisions, the goodness-of-fit tests (Clauset et al., 2009) found that both a power-law and a lognormal distribution are valid hypotheses for the data with  $p$ -values of 0.74 for power-law and 0.50 for log-normal respectively (with the  $p$ -values for Poisson and exponential distributions being 0).

The direct comparison (Clauset et al., 2009) of the power-law and lognormal distributions again indicate that both models potentially fit. However, the estimated lognormal distribution with an  $x_{min}$  value of 4 seems to be a slightly better fit than the estimated power-law distribution with an  $x_{min}$  value of 21

For the out-degree distribution of legal propositions to individual court decisions, the results are different though. Here the goodness-of-fit test clearly favors a lognormal distribution (with a  $p$ -value of 0.42 and an  $x_{min}$  value of 7, while all other distributions have a  $p$ -value close to 0).

When investigating the court decisions with the highest amount of incoming citations from legal propositions, we find 20b215/10x from 2012 (tenancy law) is referenced in 96 RS and 20b1/09z from 2010 (leasing agreements) in 77, followed by 15Os42/92 (criminal law). In total, 12 court decisions have an in-degree greater than 50, belonging to a time period from the 1980s to 2016. Thus, the in-degree of an individual court decision seems to be a meaningful predictor for node importance in Network C. On average, court decisions are cited by 3.2 RS.

The legal proposition with the highest out-degree is RS0042963 (civil procedural law), which refers to 583 decisions, followed by RS0043758 (civil proce-

dural law) referring to 446 decisions. On average, a RS aggregates its content from 4.5 decisions. Note that RS that are prominent in network B have a significantly higher amount of outgoing links than average (between 69 and 583 links).

However, the ten most relevant nodes according to the authority score are disjoint from the ten nodes with the highest in-degree. This finding might be explained by the different nature of Network C, since nodes are not strictly cited but summarized in RS with similar content. Similar to network B, it is bipartite, which might, again, impact the validity of the authority score as a predictor for importance of a node.

The node with the highest authority score is 1Ob258/11i (civil procedural law, immission reduction), followed by 1Ob202/13g (civil procedural law), two decisions (5Ob7/74, 5Ob8/74) that are not available as full text and 10ObS100/11w (social law).

Figure 5 shows the incoming and outgoing citations for Network C. The lower numbers for 2017 indicate that not all decisions of this year have been processed and aggregated into RS yet. Also note that our data-set contains about 25% of nodes that are not available as XML files and thus cannot be part of this analysis since they have no decision date.

The distribution in Figure 5 b) shows that RS pointing to reference numbers are spread over the whole time period under investigation. We also notice that most RS do not include very old decisions (i.e. court decisions that have been made before 1950).

## 5 LIMITATIONS AND OUTLOOK

The case study discussed in this paper, only takes into account citations by reference number (i.e. individual court decisions) or by legal propositions. However, other types of citations are also possible, such as references by collection number for example. Furthermore, the data that we analyzed was limited to the data provided by the RIS database which does not (yet) offer the complete set of all decisions since 1922 and tends to omit older decisions from the time before the RIS was established.

Moreover, so far we only analyzed structural properties of the corresponding citation networks. In our future work, we plan to investigate the semantic purpose of the different citations. In addition, we did not make a distinction between the different fields of law. This is because the metadata of the XML files do not contain sufficient information to determine the exact field of law a court decision belongs to. A very broad distinction could be established in future research by looking at the type of legal matter as encoded in the

reference number which could be used to determine if a decision belongs to criminal law or civil law. For a detailed analysis, a finer level of distinction would be required though.

The analyses of Network A indicate that the number of incoming citations alone is a poor predictor for the (legal) significance of a node. In the future, this could be addressed by taking the time-span into account where nodes received citations.

## 6 CONCLUSION

In this paper, we presented a case study on a structural analysis of three legal citation networks derived from Austrian Supreme Court decisions.

The case study showed that the popularity of citations referring to individual court decisions decays with time and very old nodes are hardly cited at all, indicating a dynamically evolving jurisdiction that does not rely on direct citations of landmark cases.

Moreover, court decisions do not tend to accumulate many citations over a longer time period, the most-cited nodes gained their citations in brief time periods of two to three years, indicating a fast obsolescence of popularity in decisions. In our future work, the detection of node importance could be improved by taking the time period into account in which a node received citations.

In contrast, legal propositions (RS) that aggregate court decisions are cited more often by subsequent court decisions and tend to accumulate citations over a longer period of time. The outgoing citations of RS show that recent decisions are favored over older ones and only a small fraction of RS include at least one link to an old decision (before 1950).

The popularity of RS prospectively results from the fact that citing a single RS allows referencing a number of related court decisions at once. In addition, it is easier to look up a single RS than a larger number of individual decisions. Future research could address the question if and under which conditions the popularity of RS declines over time or how the popularity of a RS changes if a new decision is added to it.

Furthermore, our case study found that prominent RS aggregate a higher number of decisions than the average RS. Referencing many decisions thus seems to be an indicator of RS importance, even though the RS with the highest number of references to decisions are not necessarily the most-cited RS.

Moreover, it should be noted that the temporal evolution of citations is likely to be affected by the availability of information technology and information retrieval systems, which significantly facili-

tate research for related court decisions, leading to a greater overall amount of citations.

The results of this study might help to develop interactive visualization tools or recommender systems to help legal professionals navigating related material for a particular legal matter.

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