Constitutional Court Decisions as a Network of Precedents? A Network Theory-Based Analysis of the Jurisprudence of the Constitutional Court of Hungary

Associate professor **Ádám AUER**[1]
Research assistant **Gábor NÉMETH**[2]
Assistant professor **Endre ORBÁN**[3]
Senior research fellow **Péter POLLNER**[4]

Abstract

Citation networks reveal the flow of knowledge among documents and the interaction between topics. Under undisturbed conditions eg., in case of scientific publications, the information flux results from free association and from searching for contextual references. In such systems, the branching of topics over time leads to a wide horizon of knowledge. As the widening progresses, it becomes harder and harder to ensure the consistency and to avoid contradictions. Here, we present a case study and a model for a citation network, between the legal decisions of the Constitutional Court of Hungary, where an external effect introduces a bottleneck in the network topology of information passing. We show that the effect of the bottleneck is only temporary, and after a transition, the knowledge flow revives. On the other hand, we show that referring to earlier knowledge becomes indirect after the bottleneck.

Keywords: network dynamics, judiciary network, decisions of Constitutional Court of Hungary, citation network.

JEL Classification: K10, K19

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[1] Ádám Auer - University of Public Service Ludovika, Budapest, Hungary, auer.adam@uni-nke.hu ORCID: 0000-0002-9219-4716.
[2] Gábor Németh - University of Public Service Ludovika, Budapest, Hungary, nemeth.gabor@hal.elte.hu ORCID: 0009-0005-2578-2816.
[3] Endre Orbán - University of Public Service Ludovika, Budapest, Hungary, orban.endre@uni-nke.hu ORCID: 0000-0001-5714-8565.
[4] Péter Pollner - Semmelweis University, Budapest, Hungary, pollner.peter@emk.semmelweis.hu ORCID: 0000-0003-0464-4893.

1. Introduction

In the past decades, network science has become one of the important approaches to the analysis of complex systems ranging from the micro-scale such as the chemical pathways within cells up to the level of the global economy and the entire human society.[5] The statistical features of the extracted graph topology usually follow universal trends, such as being small-world[6], having a scale-free (or in more general terms, a strongly in-homogeneous) degree distribution[7], possessing a high clustering coefficient[8], and often displaying sings of community structure.[9]

In the field of law[10] citation networks (composed usually of documents and cross-references between the documents) have been among the systems to be studied in the aforementioned approach right from the beginning, e.g., the scale-free nature of the citation distribution of scientific publications was one of the first examples for observing power-law decaying empirical degree distributions in large-scale real networks.[11] A noteworthy property of citation networks is the inherently directed nature of the connections, always pointing from a later appearing document towards a previous, already existing document. On the one hand, this allows the study of the hierarchical nature of the underlying system as shown for example[12], focusing on the directed networks obtained between scientific journals by aggregating the citations between

[5] Albert Réka, Barabási Albert-László, "Statistical mechanics of complex networks," *Rev. Mod. Phys.* 74, (January 2002): 47–97.; J.F.F. Mendes, S.N. Dorogovtsev, *Evolution of Networks: From Biological Nets to the Internet and WWW.* (Oxford: OUP, 2003); M.E.J Newman, A.L. Barabási, D.J. Watts (Eds.), *The Structure and Dynamics of Networks.* (Princeton and Oxford: Princeton University Press, 2006).

[6] S. Milgram, "The small world problem," *Psychol. Today* 2 (May 1967), 61–67., M. Kochen (Ed.), *The small world*. (Norwood NJ: Ablex, 1989).

[7] M. Faloutsos, P. Faloutsos, C. Faloutsos, "On power-law relationships of the internet topology," *Comput. Commun. Rev.* 29 (4 1999) 251–262. doi:10.1145/316194.316229.; Barabási Albert-László, Albert Réka, „Emergence of scaling in random networks," *Science* 286, (Oct 1999) 509–512. doi:10.1126/science.286.5439.509.

[8] D.J. Watts, S.H. Strogatz, "Collective dynamics of 'small-world' networks," *Nature* 393 (1998) 440–442. doi:10.1038/30918.

[9] S. Fortunato, "Community detection in graphs," *Physics Report* 486 (Jun 2009) 75-174 http://www.sciencedirect.com/science/article/pii/S0370157309002841, doi: https://doi.org/10.1016/j.physrep.2009.11.002; S. Fortunato, D. Hric, "Community detection in networks: A user guide," *Physics Reports* 659 (2016), 1 – 44. http://www.sciencedirect.com/science/article/pii/S0370157316302964, doi: https://doi.org/10.1016/j.physrep.2016.09.002. community detection in networks: A user guide.; H. Cherifi, G. Palla, B. Szymanski, X. Lu, "On community structure in complex networks: challenges and opportunities," *Appl. Netw. Sci.* 4, (2019) 117. doi:10.1007/s41109-019-0238-9.

[10] C. Coupette, J. Beckedorf, D. Hartung, M. Bommarito, D.M. Katz, "Measuring law over time: a network analytical framework with an application to statutes and regulations in the United States and Germany." *Front Phys* 9 (2021) 9:269:1-269:31. https://doi.org/10.3389/fphy.2021.658463.

[11] S. Lehmann, B. Lautrup, A.D. Jackson, „Citation networks in high energy physics," *Physical Review* E 68, (2003) 026113. URL: https://link.aps.org/doi/10.1103/PhysRevE.68.026113, doi: 10.1103/PhysRevE.68.026113.; S. Redner, "How popular is your paper? an empirical study of the citation distribution," *Eur. Phys. J. B.*, 4 (1998), 131–134, doi: https://doi.org/10.1007/s100510050359.

[12] G. Palla, G. Tibély, E. Mones, P. Pollner, T. Vicsek, "Hierarchical networks of scientific journals," *Palgrave Communications* 1 (2015) 1–9. URL: https://www.nature.com/articles/palcomms201516, doi: 10.1057/palcomms.2015.16.

published papers. On the other hand, from a dynamical point of view, the pathways of citations can also reveal the flow of knowledge between different scientific fields, and this process can have non-Markovian properties.[13]

Beside graphs obtained from citations between scientific publications, the networks representing the web of connections between judiciary documents can be of major interest as well. One of the first studies on this topic was focusing on an importance measure for selecting the most influential Supreme Court decisions.[14] The resulting suggestions were validated by future citations, making the proposed measure superior over simple metrics relying only on the immediate neighborhood. In a related recent work, a link prediction model was proposed for the development of citations in the case-to-case citation network of the Court of Justice of the European Union.[15]

Based on the earlier citation patterns, the method was able to foresee future references, where naturally the accuracy of the predictions decayed as a function of the length of the considered time window.

Judiciary citation networks may contain also weighted connections as suggested[16], focusing on the network representation of Canadian legislation based on citations between the Acts. The links were originating from legislation text references to other acts, where multiple references increased the weight of the given connection. This type of networks can display an intricate structural organization at the level of communities as well. E.g., in a study of the Brazilian constitution, a network between the articles was constructed based on internal references between the provisions, with emergent communities in the network topology containing articles that share codes or communicative standards.[17]

In the present work we study a judiciary citation network where a major bottleneck is arising during the time evolution of the system, preventing the formation of links pointing from nodes appearing after the bottleneck to nodes present before the bottleneck. The network under investigation is corresponding to the citation network between the legal decisions of the Constitutional Court of Hungary[18] (CCoH), where in 2012 the prior decisions of the CCoH were repealed following the adoption of the new

[13] M. Rosvall, A. Esquivel, A. Lancichinetti, J.D. West, R. Lambiotte, "Memory in network flows and its effects on spreading dynamics and community detection," *Nat. Commun.* 5 (2014) 4630. doi: https://doi.org/10.1038/ncomms5630.

[14] J.H. Fowler, T.R. Johnson, J.F. Spriggs, S. Jeon, P.J. Wahlbeck, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the U.S. Supreme Court," *Political Analysis* 15 (2007) 324–346. https://www.cambridge.org/core/journals/political-analysis/article/network-analysis, doi: 10.1093/pan/mpm011.

[15] E. Mones, P. Sapieżyński, S. Thordal, H.P. Olsen, S. Lehmann, "Emergence of network effects and predictability in the judicial system," *Scientific Reports* 11, (2021) 2740. https://www.nature.com/articles/s41598-021-82430-x, doi:10.1038/s41598-021-82430-x.

[16] Chris Allison "Network Graph of Canadian Legislation" 2015, https://medium. com/@ToferC/network-graph-of-canadian-legislation-8c6228bd3d0d.

[17] R.S.e. Silva, "Network analysis as an alternative way to interpret constitutions," *PLOS ONE* 16 (2021), e0259461, https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0259461, doi: 10.1371/journal.pone.0259461.

[18] Another study on freedom of expression: Ződi Zs, "Az Alkotmánybírósági ítéletek hálózatának elemzése" *MTA Law Working Papers*, (22 2020).

constitution, the Fundamental Law of Hungary. Nevertheless, the CCoH upheld its former jurisprudence due to the continuity of content between the old and the new constitution, and the pathways of citations were not completely blocked between the two parts of the network, instead they were restricted to chains including a node from 2012, leading to the emergence of the mentioned bottleneck.

In the study, we examined the Constitutional Court decisions until 2020, when the COVID 19 pandemic occurred. Afterwards, there were several changes (e.g. the introduction of a special legal order – the state of danger[19]) that may have affected the previous trends and which require further separate research.

By studying the time evolution of different structural properties of the citation network we can see that the above mentioned restriction leads to abrupt changes, however, the system seems to recover from the induced "shock" over time. Beside the analysis of the network representing the references between the legal decisions, we also propose a simple synthetic model reproducing the bottleneck effect observed in the real data.

2. Legal background of the network of precedents

The role of constitutional courts is to interpret and to enforce constitutional provisions. They take constitutions as legal documents – Grundnorm[20] - and hold their decisions on the basis of its rules together with an openly available reasoning. According to the formal approach, such a process would be a mere deduction: courts first rely on the norms, then apply them to the facts and hold consequences. Nevertheless, the application of the norms is a way more complex practice as short constitutional norms are built up of words that are prone to interpretation.[21] Therefore, these norms are surrounded by their understandings and as a result, the constitutional text and its interpretation will together form the constitution itself. This means that interpretation always adds to the content of the constitution as it defines the meaning of the normative text.

Interpretation uses different methods,[22] and one of them are the precedents which bring the attention of the reader to the justification of the judgements rather then on the consequences, the operative part of the judgements. In this regard, one can

[19] Erdős Cs., Tanács-Mandák F., "The Hungarian Constitutional Court's Practice on Restrictions of Fundamental Rights during the Special Legal Order (2020–2023)." *European Politics and Society* 25 (3, 2023) 556–73. doi:10.1080/23745118.2023.2244391; Kecső, Gábor, Boldizsár Szentgáli-Tóth and Bettina Bor, „Emergency Regulations Entailing a Special Case of Norm Collision Revisiting the Constitutional Review of Special Legal Order in the Wake of the COVID-19 Pandemic", *Juridical Tribune - Review of Comparative and International Law* 14, no. 1 (March 2024): 5-26.

[20] H. Kelsen, *Pure Theory of Law* (Clark: Lawbook Exchange, 2009).

[21] See an interesting article about the interpretation's pattern in context of network science: C. Coupette, D. Hartung, J. Beckedorf, M. BötherD. M. Katz, "Law Smells Defining and Detecting Problematic Patterns in Legal Drafting," *Artificial Intelligence and Law* 31 (2023) 335-368. https://doi.org/10.1007/s10506-022-09315-w.

[22] R.H. Fallon, "A constructivist coherence theory of constitutional interpretation," *Harvard Law Review* 100 (April 1987), 1189-1286.

observe that the jurisprudence of constitutional courts is generally based on precedents (there are few exceptions e.g. France): previously decided cases and doctrines developed in earlier judgements determine the outcome of future cases. This means that besides the widely accepted feature that constitutional court rulings are binding vertically toward other stakeholders (lawmakers, ordinary courts), constitutional precedents are important even horizontally as they legitimise new decisions. This characteristic of constitutional adjudication is similar to common law courts where this attribute of the legal system is de jure acknowledged.[23] Yet, in continental legal system this is a rather de facto development.

Despite the lack of legal obligation, the reasons behind the acceptance of precedents are quite clear. According to the underlying principle (stare decisis), similar cases have to be decided in the same way as this approach will satisfy the requirement of formal justice. As a corollary, an important function of precedents is to exclude arbitrariness. Furthermore, precedents help courts to save time and energy when dealing with similar cases, and last but not least, they provide an opportunity to confirm the correctness of their previous decisions and thus building their authority.[24] In this regard, a special form of references are foreign precedents which aim to demonstrate that the court is in line with other jurisdictions and thus legitimizing the outcome of a specific decision.

While the already existing decisions provide a framework, a lens for the new cases[25], the precedents can also be re-evaluated.[26] As a result, it might happen that a court will not follow a precedent (overruling) either because it considers the previous decision as being erroneous or because of some detected changes within the society (living tree doctrine). Furthermore, overruling can also be a sign of judicial activism in the sense that a court may willingly depart from a previous constitutional path as in the case of the Warren court in the USA.[27]

Yet, another special possibility of overruling might arise when a new constitution is adopted. In such a case, and especially when there is no rupture within legality, the constitutional court can decide whether it follows its previous precedents or not. Such an event happened in Hungary with the adoption of the Fundamental Law of Hungary in 2012 where the Constitutional Court of Hungary (hereinafter: CCoH) upheld its former jurisprudence due to the continuity of content between the old and the new constitution (22/2012 CC Decision). At the same time not only the constitutional text has been renewed in Hungary, but also the powers of the CCoH underwent significant changes following the introduction of the constitutional complaint procedures as a

[23] P.S. Atiyah, R.S. Summers, *Form and Substance in Anglo-American Law. A Comparative Study of Legal Reasoning, Legal Theory and Legal Institutions* (Oxford: Clarendon Press, 1987).
[24] Lamond, Grant, "Precedent and Analogy in Legal Reasoning", The Stanford Encyclopedia of Philosophy (Spring 2016 Edition), Edward N. Zalta (ed.), URL = <https://plato.stanford.edu/ archives/spr2016/entries/ legal-reas-prec/>.
[25] R. Dworkin R., *Law's Empire*. (London: Fontana, 1986).
[26] N. MacCormick, R.S. Summers, (Eds.), *Interpreting Precedents. A Comparative Study*. (Brookfiled: Ashgate, 1997).
[27] J.H. Fowler, S. Jeon, "The authority of Supreme Court precedent," *Social Networks* 30 (2008) 16-30. https://www.sciencedirect.com/science/article/pii/S0378873307000378,doi:10.1016/j.socnet.2007.05.001.

means of individual fundamental rights protection.[28] Furthermore, the constitution maker adopted the Fourth Amendment to the Fundamental Law stating that 'the decisions of the Constitutional Court of Hungary made prior to the entry into force of the Fundamental Law are repealed.' This strong intervention can be interpreted as an attempt to enhance the creation of new constitutional conventions. Nevertheless, the CCoH upheld the potential use of its previous decisions. Admittedly, their use is not automatic as it was thought earlier but needs reasoning.

Departing from this observation, our article seeks to examine the case law of the CCoH as a network of decisions. An examination of the jurisdiction of the CCoH may provide an answer to the question of which precedents play a central role and what the pattern of the network is, if any. Indeed, in the system of fundamental rights, there is a common test used to assess the restriction of the rights. As a result, the network of decisions of the CCoH may consist of several components that may be interconnected. The network approach can also show to what extent the CCoH builds on its previous practice.

3. Results

3.1. Citation network of the Constitutional Court of Hungary (1990-2019)

As the first step of our study, we have to assign the role of nodes and links in the legal system. In the practice of the precedent system, the decisions (nodes) can influence other decisions in the future. This influence can happen through a precedent connection (links). In the connection between two decisions, the decision appearing later in time is referring to an earlier precedent, thus, in the network representation the links are always pointing from later appearing (newer) decisions to the earlier appearing (older) decisions. The decisions by the CCoH form a directed network with 7657 nodes and 48320 links. The links between the nodes were identified by natural language processing of the text of the decisions, where the citations were extracted by pattern matching and the cited decisions were found with their case identifiers. Figure 1 shows the distribution of decisions and orders.

The network is well connected, the majority of the nodes are part of a giant weakly connected component, containing more than 98% of the nodes and 99% of the links. So, despite of the many different legal topics in connection with fundamental rights, the majority of the decisions are in a direct or indirect relation with each other. Beside the giant component, some small components appear as well, mostly related to constitutional law issues that examine a separate problem unrelated to any other fundamental right.

The indegree and outdegree distributions of the network are shown in Fig.1,

[28]L. Csink, B. Schanda, *The constitutional court*, in: Zs. A. Varga, A. Patyi, B. Schanda, (Eds.), *The Basic (Fundamental) Law of Hungary: A Commentary of the New Hungarian Constitution*. (Dublin: Clarus Press, 2015) 185–196; O.W. Lembcke, C. Boulanger, "Between revolution and constitution: The roles of the Hungarian constitutional court" in: *Constitution for a Disunited Nation - on Hungary's 2011 Fundamental Law*, ed. Tóth G.A. (New York, Budapest: CEU Press, 2012), 269–299.

indicating a relatively large inhomogeneity among the nodes, where hubs can have a number of connections exceeding the average considerably. The decay of the distributions are slow, similarly to the often reported scale-free behavior in a wide range of social, technological and biological networks.[29]

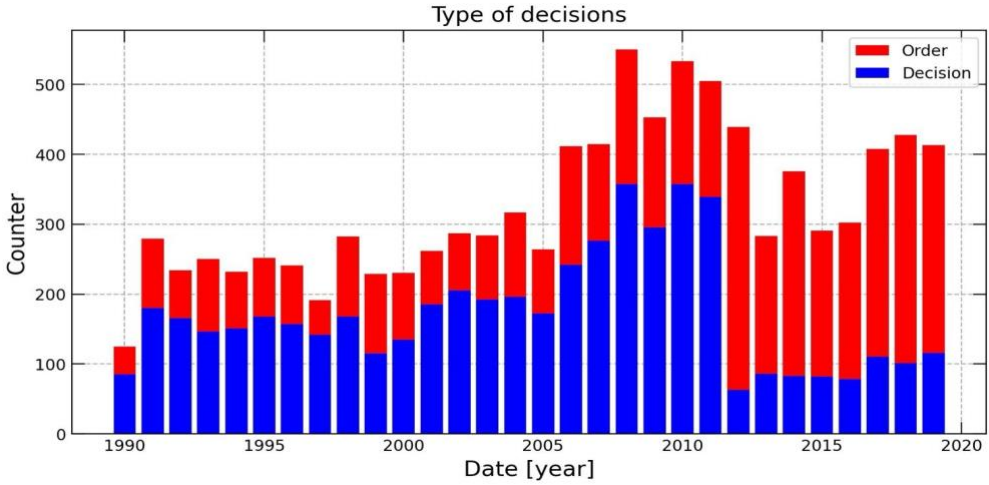

Figure 1: Decisions and orders in the case-law of CCoH

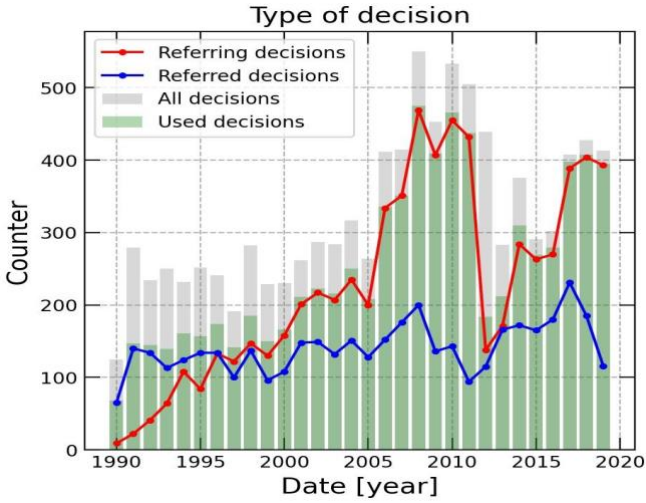

Figure 2: Summary table of decisions, by number of decisions cited and referred to, by year

[29] Albert Réka, Barabási Albert-László, "Statistical mechanics of complex networks," *Rev. Mod. Phys.* 74, (January 2002): 47–97.; Barabási Albert-László, Albert Réka, „Emergence of scaling in random networks," *Science* 286, (Oct 1999) 509–512. doi:10.1126/science.286.5439.509.

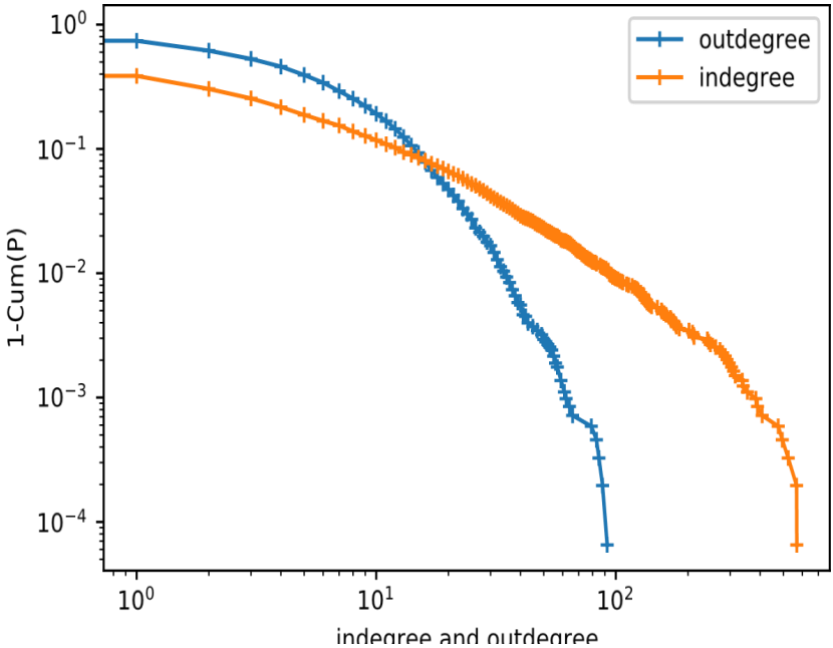

Figure 3: Indegree and outdegree distributions of the network. The complementary cumulative function is shown for both quantities.

3.2. Reference chains

Chains of connections can be of major interest in citation networks in general. E.g., in case of a network between scientific papers, these can represent the flow of knowledge[30], whereas in networks based on jurisprudence, the flow of influence of previous decisions. These chains may consist of several parts, with many years difference between their youngest and oldest end. They build the directed skeleton of influence: long chains indicate several small steps, where the very first node represents an initial decision setting the base topic of the chain, while intermediate members of a chain show the flexibility of the legal decisions as they may slightly bend to the needs of the society or as the interpretation context and even the text of the constitution (the very base of all decisions) may change with time.

In order to get information about the accumulated changes in the context of a decision, we have considered the longest chain for each node in the network that the given node is part of either as a starting or as an ending or as an intermediate member. We assign a time dependent colour to each node that shows on a [0,1] range how recent or how old is the decision. This colour feature is calculated as follows. A snapshot network of decisions and of their precedents are created for each year. For a given snapshot for each node all possible directed paths are determined that include the given

[30] M. Rosvall, A. Esquivel, A. Lancichinetti, J.D. West, R. Lambiotte, "Memory in network flows and its effects on spreading dynamics and community detection," *Nat. Commun.* 5 (2014) 4630. doi: https://doi.org/10.1038/ncomms5630.

node. Then the longest path is selected, which is a directed chain of nodes. For the selected chain we define the following quantities:

- Path length : The length of the selected chain, given by the number of links in the chain.

- Position in the chain: The number of hops along the chain until the given node. The counting of hops starts from the source node in the chain (the youngest node) with zero.

- Position ratio: The ratio of the previous two metrics, the position in the chain over the length of the chain, providing a value always between 0 and 1. For small values, the node is closer to the younger end of the chain, whereas a value close to 1 indicates that the node is close to the root (the oldest node) in the chain. This quantity is defined to be 0 for a source node, even in the case when the path length is zero.

Note, when a node is part of several paths with equal maximal length, the position ratio is independent from the chosen particular path.

The decisions of the CCoH is represented by a directed, coloured, time dependent network, where the node colors are the position ratios for a given node in a given yearly snapshot.

We will show below that the precedent selection dynamics utilizes this color quantity and results in an uncommon citation behavior observed for the first time in this study.

An illustration of the citation mechanism that chooses a precedent along a reference chain is shown in Fig.4.

The evolution of these metrics is shown in the 5a., 5b. and 6. figures, in comparison with a simulated network.

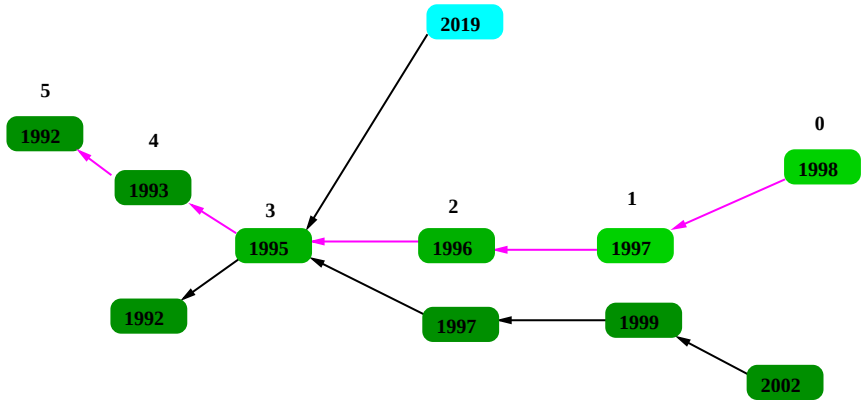

Figure 4: The choice of a precedent for a decision in 2019

The snapshot network, containing the decisions from 2018 and earlier, consists of nodes with green color. The new decision in 2019, indicated with a blue node, refers to a precedent from year 1995. This precedent is a member of several paths and its position is determined from the longest path. The edges of the longest path are in pink colour, the nodes along this path are shaded according to the position ratio and the position values are indicated above the nodes. The position value of node 1995 is 3, and

its position ratio is 0.6. The nodes along a shorter path are not counted, and they are coloured with the same green colour indicating they membership in the snapshot network but having no other roles.

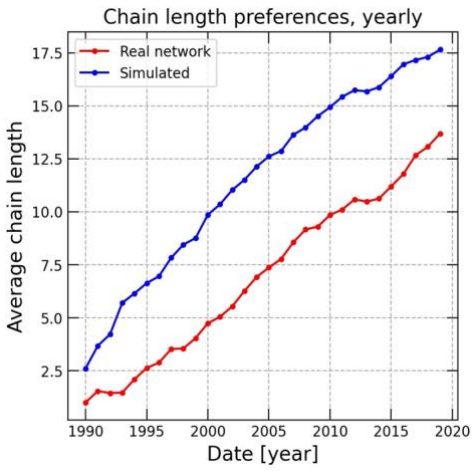

Figure 5a

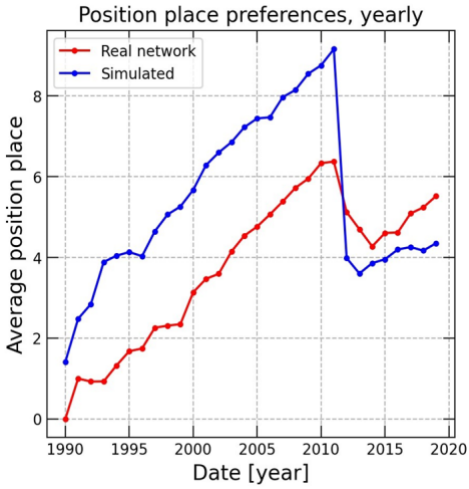

Figure 5b

Figure 5: a) The average length of the reference chains increased over the evolution. This indicates that there are edges that targets the youngest end of the reference chains. b) The average position place increased until a break point in 2012, dropped multiple places, until returned its previous growing tendencies.

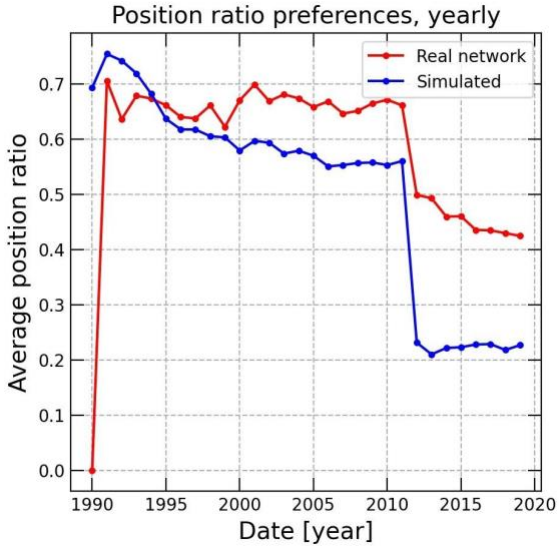

Figure 6: The position ratio fluctuated around a certain value before 2012, after dropping in 2012 it remained close to constant around a lower value.

3.3. The network model of the jurisdiction of CCoH

In order to find effects that can cause this behaviour, we created a model to reproduce the previous results which were measured the full network, including the rules and the decisions. The base of this model is a preferential attachment model, with modified preferential rules.[31]

In this model, at each time step a new node is added to the network, with edges targeting the existing nodes. These targets are selected randomly, but each node may have a different probability weight factor. These weights are based on the preferential equation (1) and its components are recalculated as the network is growing. The number of nodes in a year and their out-degrees are chosen randomly from distributions, which were fitted on the measured data.

The main goal of this model is to simulate the selection process of legal experts, how they select precedents for supporting the reasoning of a decision. The model assumes three factors for the process and considers them as preferential weights for the selection:

- *Ageing of the precedents*: The topicality of an earlier decision decreases with time, therefore younger ones are preferred. So this weight depends on the time between the actual decision i and the precedent j, t_i and t_j. Because of the restrictions that were introduced in the act 22/2012, this factor takes into account the ageing around the T_0 = 2012 time point differently. Hence the ageing *time* factor depends on three variables: $Z_{time}(t_i,t_j,T_0)$.

- *Legal topic*: There are well known legal topics, such as the right to property or freedom of speech. Because connections between decisions with the same legal topic are more probable, the topic factor is considered as a weight $Z_{topic}(C_i,C_j)$, where C_i and C_j are the topic clusters with the membership of decisions i and j respectively. Note, that we will consider this weight only for nodes within a common cluster, though, a more relaxed weight with decreasing topic similarity would be possible as well, but it would lead to an over-complicated model.

- *Distance from first precedent*: The origin or the base-decision of a legal topic is well known to the lawyers. However, they can choose different precedents that follow the first decision, because the actual legal meaning can change slightly with time and context. This factor is considered with an additional weight. This factor enhances linking the actual decision to a precedent residing along a reference chain to a base-decision. Because of the traditional mechanisms that associate a decision with a legal topic in the common sense, this weight depends on the position of the precedent on the reference chain. The position is best described with l_j, see the Methods section for details of the definition. Due to the restrictions introduced in year T_0 this factor depends on T_0 besides l_j and will be denoted as $Z_{chain}(l_j,T_0)$.

Now we turn to quantitative modeling by considering the factors as pairwise interactions. The probability of the ith decision to choose the jth decision as precedent results from a linear combination of the above defined weights:

[31] Barabasi Albert-László, *Network Science* (Cambridge: Cambridge University Press, 2016).

$$Z(i,j) = \mu Z_{topic}(C_i, C_j) + \nu Z_{time}(t_i, t_j, T_0) + K Z_{chain}(l_j, T_0) \quad (1)$$

$$P(i,j) = \frac{Z(i,j)}{\sum_{i,j} Z(i,j)} \quad (2)$$

For simplicity, we consider the topic weight only for the cases, where the decision and the precedence are in the same topic cluster. Hence we consider this weight with a Kronecker-delta function between the clusters of the decision *i* and precedent *j* as

$$Z_{topic}(i,j) = \delta_{Ci,Cj},$$

where $\delta_{Ci,Cj}$ is 1 if C_i and C_j are the topic clusters, else it is 0.

The weight, related to the ageing, consists of two terms. If the decision *i* and *j* are both before or both after the time point T_0, their weight Z_{time} follows a reciprocal $Z_{time}(i,j) \sim \frac{1}{t_i - t_j + \varepsilon}$ function of the difference of the dates. Note, that *i* represents the decision and *j* represents the precedence that is referenced, hence $t_i \geq t_j$. In order to set an upper limit for this weight, we set ε = 1 year. The second term describes the effect of the act 22/2012 as follows. If decision *i* is after T_0 and its cited precedence *j* is before T_0, the Z_{time} decays rapidly with t_j, but it is independent from t_i: $Z_{time}(i,j) \sim e^{-\lambda(T_0 - t_j)}$. The separate time intervals, where the two terms are valid, are enforced with Heaviside functions:

$$Z_{time}(i,j) = \frac{1}{t_i - t_j + 1} \cdot (H(t_i - T_0) \cdot H(t_j - T_0) + (1 - H(t_i - T_0)) \cdot (1 - H(t_j - T_0))) + H(t_i - T_0) \cdot (1 - H(t_j - T_0)) \cdot e^{-\lambda(T_0 - t_j)}.$$

The third weight introduces a preference for the choice of the cited decision according to the position of the precedence in the history of a legal topic. It takes into account that a precedent is a member of a reference chain and utilizes the position ratio metric introduced above for quantitatively describing the position. Based on the observation presented in Fig 4. the average relative position of the cited preferences is constant over the years. Only the restriction introduced in T_0 changes the constant parameter of this process. The model incorporates this uncommon citing process by referring connections to the precedents close to the average places:

$$Z_{chain}(i,j) = \delta_1(L_j * (l_j - E(l_j, T_0)))$$

where $\delta_1(x)$ is the indicator function around $x = 0$ that takes the value 1 if $x \in [-1,1]$ and 0 otherwise. The L_j denotes the length of the reference path that goes through *j* in the time point when *i* arises and l_j is the position ratio along this path. The $E(l_j,T_0)$ is the expectation value of the position ratio. We approximate this function with a bi-valued step function as $E(l_j,T_0) = E_1(1 - H(t_j - T_0)) + E_2 H(t_j - T_0)$.

Parameter names	Value
μ	500
ν	134
λ	1

K	400
E_1	0.65
E_2	0.45

Table 1: The values of the final parameters of the model.

The model was meant to reproduce the transition in 2012, where the position ratio and the position place metrics are rapidly changing, while preserving the metrics general behaviours in terms of the direction and speed of their growth. An additional shift is visible in the chain metrics, however this is not a fault of the model, because this distance was not part of the fitting. Only the slope of the metric curves are important, which show a good fitting in the intervals divided by T_0. The accuracy of the fitting is adequate based on existence of the rapid transition and the close slope in the corresponding intervals, before and after T_0.

We have optimised the model parameters by evaluating the model with several possible settings of the parameter values. The E_1 and E_2 parameters are directly measurable from the observed data. We have varied the value of λ with several, randomly chosen values of the other, still undetermined parameters. We found, that the model is quite sensitive on this parameter, but it produces meaningful results only in a narrow range. We have set it to $\lambda = 1$. Finally, we have varied the other three parameters and minimised the mean square distance of the yearly average position ratio and average chain length between the model and the observed values. This optimisation process lead to the parameter values shown in Table 1.

3.4. The reference heatmap

It is widely known that several fundamental rights infringements can be identified within the same case. For example, in case of an expropriation, the violation of the right to property can be raised as a first aspect. Nevertheless, such a case may bring up the infringement of the right to a fair administration, because an expropriation may be based on a decision by a public authority. There may also be an infringement of the right to a fair trial, because the review of the decision of the public authority is subject to a judicial procedure. Finally, it may also be questioned why the expropriation is allowed by the legal system at all, i.e. it is identified as a rule of law issue. On this basis, the petitioner can immediately identify four different violations of fundamental rights. Following this observation, a network can be drawn that shows which fundamental rights are identified by the petitioners together with the right to property. The result is a heatmap that can provide an answer as to which fundamental rights are most frequently invoked together with the right to property, which is visible in the 8a. figure. The decision of the CCoH can then take two directions. On the one hand, it may reject the petition. In this case, if multiple fundamental rights violations are raised, it must examine all them provided that they are capable of being examined on their merits. On the other hand, if the CCoH confirms the petition, it is sufficient that only one cited fundamental right violation to be approved. In other words, if one of the alleged fundamental right violations can be established on this basis, the court will not go further

to examine the other aspects of the petition. This is where the network method can help.

If we look at an example, in the 8b. figure: Article XIII the right of property. Besides the right to property (Article XIII), the most cited articles are: the violation of the rule of law (Article B), the violation of the right to a fair trial (Article XXVIII) and the rule stating the main rule of limitation of fundamental rights. In our example (147 cases), we see that about 2/3 of the cases are rejected (107 cases). The violation of the right to property (10 cases) and the right to a fair trial were found in equal proportions (11 cases). In other cases, other violations of fundamental rights arose, such as the prohibition of discrimination (4 cases).

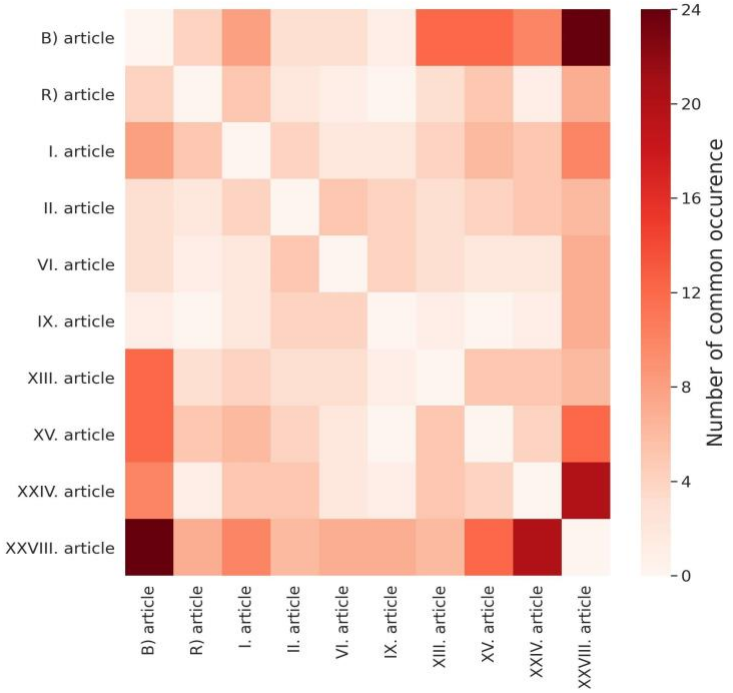

Figure 7: The reference heatmap shows the number of common occurrence between the top 10 most cited article in the Basic Law of Hungary. For example, in the row of the "I. article" and with the column of the "XIII. article" the intensity of the cell shows the number of common occurrence. The heatmap is symmetric through its diagonal.

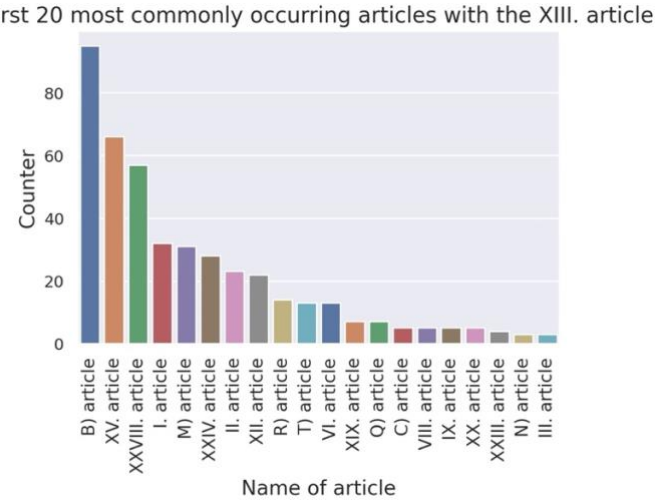

Figure 8: The first 20 most commonly referred Articles of the Constitution with the XIII article.

4. Conclusions

The network of references of the CCoH's case law shows a unified system, with orders and decisions forming a single network. The network of citations is a good way of demonstrating that there has been continuity between decisions since the Constitutional Court began its work. Despite the fact that both the source of fundamental rights and the competences of the Constitutional Court changed in 2012 and despite the repeal of the former jurisprudence, continuity in the network of references can still be demonstrated. It can't be observed cyclical variation, neither by person nor by presidency. Nevertheless, the impact of the Fundamental Law can be detected in the pattern of the network through the changes of the average position ratio of the citations: after 2012 the average has dropped to 0.2-0.4 level which proves that CCoH tended to focus on its newest decisions rather than on the older elements of the chains.

The network scientific methods provided a good base for the system analysis, as the citations between the individual cases can be represented by network connections. Beside the usual network methodology, we developed new metrics that could describe the characteristics of the citation rules. With their help we found empirical proof of a transition in the legal system. In addition, we successfully developed a model that could reproduce the CCoH citation properties. This preferential attachment model is unique in terms of its preferential rules, imitating the human reasoning of lawyers with empirical simplifications.

However, network analysis has its own limits as it does not provide a reassuring automatic answer to an important issue: citing decisions alone does not predict the outcome of a case. Therefore, the usage of precedents and the conclusion of the decisions shall be treated separately from each other. The question whether a constitutional court not just cites precedents while interpreting the constitution, but also

enforces them in a right manner (or in other words: it reaches the right conclusion), requires a legal and qualitative examination of the decisions.

Bibliography

1. Albert-László, Barabási & Albert Réka, „Emergence of scaling in random networks," *Science* 286, (Oct 1999) 509–512. doi:10.1126/science.286.5439.509.
2. Albert-László, Barabasi, *Network Science* (Cambridge: Cambridge University Press, 2016).
3. Allison, Chris, "Network Graph of Canadian Legislation" 2015, https://medium.com/@ToferC/network-graph-of-canadian-legislation-8c6228bd3d0d.
4. Atiyah, P.S. & R.S. Summers, *Form and Substance in Anglo-American Law. A Comparative Study of Legal Reasoning, Legal Theory and Legal Institutions* (Oxford: Clarendon Press, 1987).
5. Cherifi, H., G. Palla, B. Szymanski & X. Lu, "On community structure in complex networks: challenges and opportunities," *Appl. Netw. Sci.* 4, (2019) 117. doi:10.1007/s41109-019-0238-9. 2019.
6. Coupette, C., D. Hartung, J. Beckedorf, M. Böther & D. M. Katz, "Law Smells Defining and Detecting Problematic Patterns in Legal Drafting," *Artificial Intelligence and Law* 31 (2023) 335-368, https://doi.org/10.1007/s10506-022-09315-w.
7. Coupette, C., J. Beckedorf, D. Hartung, M. Bommarito & D.M. Katz, "Measuring law over time: a network analytical framework with an application to statutes and regulations in the United States and Germany." *Front Phys* 9 (2021) 9:269:1-269: 31. https://doi.org/10.3389/fphy.2021.658463.
8. Csink, L. & B. Schanda, *The constitutional court*, in: Varga, Zs. A., A. Patyi & B. Schanda, (Eds.), *The Basic (Fundamental) Law of Hungary: A Commentary of the New Hungarian Constitution*. (Dublin: Clarus Press, 2015) 185–196.
9. Dworkin R., *Law's Empire* (London: Fontana, 1986).
10. Erdős, Cs. & Tanács-Mandák F., "The Hungarian Constitutional Court's Practice on Restrictions of Fundamental Rights during the Special Legal Order (2020–2023)." *European Politics and Society* 25 (3 2023) 556–73. doi:10.1080/23745118.2023.2244391.
11. Fallon, R.H., "A constructivist coherence theory of constitutional interpretation," *Harvard Law Review* 100 (April 1987), 1189—1286.
12. Faloutsos, M., P. Faloutsos & C. Faloutsos, "On power-law relationships of the internet topology," *Comput. Commun. Rev.* 29 (4 1999) 251–262. doi: 10.1145/316194.316229.
13. Fortunato, S. & D. Hric, "Community detection in networks: A user guide," *Physics Reports* 659 (2016), 1 – 44. http://www.sciencedirect.com/science/article/pii/S0370157316302964, doi: https://doi.org/10.1016/j.physrep.2016.09.002, community detection in networks: A user guide.
14. Fortunato, S., "Community detection in graphs," *Physics Report* 486 (Jun 2009) 75-174. http://www.sciencedirect.com/science/article/pii/S0370157309002841, doi: https://doi.org/10.1016/j.physrep.2009.11.002.
15. Fowler, J.H. & S. Jeon, "The authority of Supreme Court precedent," *Social Networks* 30 (2008) 16-30. https://www.sciencedirect.com/science/article/pii/S0378873307000378, doi:10.1016/j.socnet.2007.05.001.
16. Fowler, J.H., T.R. Johnson, J.F. Spriggs, S. Jeon & P.J. Wahlbeck, "Network Analysis

and the Law: Measuring the Legal Importance of Precedents at the U.S. Supreme Court," *Political Analysis* 15 (2007) 324–346. https://www.cambridge.org/core/journals/political-analysis/article/network-analysis, doi:10.1093/pan/mpm011, publisher: Cambridge University Press.

17. Grant, L., "Precedent and Analogy in Legal Reasoning", *The Stanford Encyclopedia of Philosophy* (Spring 2016 Edition), Edward N. Zalta (ed.), https://plato.stanford.edu/archives/spr2016/entries/legal-reas-prec/.
18. Kecső, Gábor, Boldizsár Szentgáli-Tóth and Bettina Bor, „Emergency Regulations Entailing a Special Case of Norm Collision Revisiting the Constitutional Review of Special Legal Order in the Wake of the COVID-19 Pandemic", *Juridical Tribune - Review of Comparative and International Law* 14, no. 1 (March 2024): 5-26.
19. Kelsen, H., *Pure Theory of Law* (Clark: Lawbook Exchange, 2009).
20. Kochen, M. (Ed.), *The small world*. (Norwood NJ: Ablex, 1989).
21. Lehmann, S., B. Lautrup & A.D. Jackson, „Citation networks in high energy physics," *Physical Review* E 68, (2003) 026113, URL: https://link.aps.org/doi/10.1103/PhysRevE.68.026113, doi: 10.1103/PhysRevE.68.026113, publisher: American Physical Society.
22. Lembcke, O.W. & C. Boulanger, "Between revolution and constitution: The roles of the Hungarian constitutional court" in: *Constitution for a Disunited Nation - on Hungary's 2011 Fundamental Law,* ed. Tóth G.A. (New York, Budapest: CEU Press, 2012), 269–299.
23. MacCormick, N. & R.S. Summers, (Eds.), *Interpreting Precedents. A Comparative Study*. (Brookfiled: Ashgate, 1997).
24. Mendes, J.F.F. & S.N. Dorogovtsev, *Evolution of Networks: From Biological Nets to the Internet and WWW.* (Oxford: OUP, 2003).
25. Milgram, S., "The small world problem," *Psychol. Today* 2 (May 1967), 61–67
26. Mones, E., P. Sapieżyński, S. Thordal, H.P. Olsen & S. Lehmann, "Emergence of network effects and predictability in the judicial system," *Scientific Reports* 11, (2021) 2740. https://www.nature.com/articles/s41598-021-82430-x, doi: 10.1038/s41598-021-82430-x. number: 1 Publisher: Nature Publishing Group.
27. Newman, M.E.J. & A.L. Barabási, D.J. Watts (Eds.), *The Structure and Dynamics of Networks.* (Princeton and Oxford: Princeton University Press, 2006).
28. Palla, G., G. Tibély, E. Mones, P. Pollner & T. Vicsek, "Hierarchical networks of scientific journals," *Palgrave Communications*, 1 (2015) 1–9. URL: https://www.nature.com/articles/palcomms201516, doi: 10.1057/palcomms.2015.16. Publisher: Palgrave.
29. Redner, S., "How popular is your paper? an empirical study of the citation distribution," *Eur. Phys. J. B.*, 4 (1998), 131–134 doi: https://doi.org/10.1007/s10010050359.
30. Réka, Albert & Barabási Albert-László, "Statistical mechanics of complex networks," *Rev. Mod. Phys.* 74, (January 2002): 47–97.
31. Rosvall, M., A. Esquivel, A. Lancichinetti, J.D. West & R. Lambiotte, "Memory in network flows and its effects on spreading dynamics and community detection," *Nat. Commun.* 5 (2014) 4630. doi: https://doi.org/10.1038/ncomms5630.
32. Silva, R.S.e., "Network analysis as an alternative way to interpret constitutions," *PLOS ONE* 16 (2021), e0259461. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0259461, doi:10.1371/journal.pone.0259461. Ppublisher: Public Library of Science.
33. Watts, D.J. & S.H. Strogatz, "Collective dynamics of 'small-world' networks," *Nature*

393 (1998) 440–442. doi:10.1038/30918.
34. Ződi, Zs., "Az Alkotmánybírósági ítéletek hálózatának elemzése" *MTA Law Working Papers*, (22 2020).