

Mapping Jurisprudence of WTO Dispute Settlement Body Using Deep Learning

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Abstract

The world trade organization (WTO) legally regulates the world trade system with its dispute settlement body (DSB). There exists a shared understanding among legal experts about how articles of WTO agreements systematically interact with each other. However, the complexity of the WTO legal framework has constrained many developing countries with limited legal knowledge and resources from fully utilizing the WTO DSB. To address this issue, I propose a new method that summarizes the systematic interactions between articles of WTO agreements. I collected past 20 years of WTO disputes and trained a neural network that mimics the reasoning process of legal experts that determines which articles to cite for given factual description of the dispute. Then I collected all the predictions from the trained neural network and fitted the summarization network using Random Forest. I verified the quality of the fitted network by checking that the network captures the important systematic interactions as explained by the Panel and Appellate body, two main judicial authorities of the WTO DSB.

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1 Introduction

The Dispute Settlement Body (DSB) of the World Trade Organization (WTO) deals with trade disputes between WTO members. WTO members file a lawsuit in WTO DSB to claim their impaired benefit related to the WTO agreements as a result of another member's possible illegal trade policy. The judicial body of WTO DSB, *Panel* or *Appellate Body*, then adjudicates the dispute and submits a report in which it expresses its judicial opinion as to whether the challenged trade policy is inconsistent to the rules of the WTO or not (?).

This process requires enormous legal knowledge and resources because the legal system of WTO is highly complex. This complexity has constrained many developing countries with limited legal knowledge and resources from fully utilizing the WTO DSB (???).

To address this issue, I provide a novel method to summarize the network of WTO articles. Currently, understanding of how articles of WTO agreements systematically interact with each other is exclusively shared among legal experts. However, by developing the method that can quantitatively summarize the systematic interaction between articles of WTO, we can lower the cost of understanding the legal system of WTO. This will help resolve the unbalanced legal capacity issue in WTO DSB.

To properly summarize the systematic interactions between articles of WTO agreements, I designed my method based on two following considerations. First, since the legal system of WTO evolves from the way how real-world dispute interacts with the regulatory content of the article of WTO agreement, I considered a way of utilizing two different types of textual data, factual description of the trade dispute and the content of each article of the WTO agreements. Second, since members strategically cite rules of the WTO agreements to encourage the third party participation (?) or to reshape the legal precedents(?), I considered a way of generalizing these member-specific strategic citations.

Upon these two considerations, this paper uses deep learning. Deep learning is empirically known as good at extracting information from the textual data. In addition to it, deep learning also generalizes the patterns inside data. Therefore, this paper designs a deep neural network that processes two different types of textual data, description of the dispute and each article content of the WTO agreements. The design mimics the reasoning process of the legal experts, where the experts read the textual description of the dispute and imagine applicable legal articles of the WTO agreements according to its regulatory content.

To train this neural network, I collected textual description of trade dispute and articles of the

WTO agreement cited for each dispute requested to the WTO DSB from 1995 to 2018. Using this collected data, I trained the neural network by enforcing the neural network to answer correctly whether a given article of the WTO agreements can be cited for the given textual description of trade dispute. After training, I fitted a network that summarizes the systematic interactions between articles of WTO agreements using *Random Forests* (??). The network is fitted as to best explain the variance of each article’s citabilities. Those citabilities are collected from the predictions of the trained deep neural network.

To verify the quality of the fitted network, I compared the fitted network with the jurisprudence of WTO DSB appearing in the Panel and Appellate Body reports. Specifically, I found three major principles of WTO DSB, *Market Access*, *Reciprocity*, and *Non-discrimination*, are clustered in the fitted network. The systematic interactions between articles of WTO agreements are formed as how the Panel and Appellate Body explained in their judicial opinions. As Panel and Appellate body authoritatively constitute the jurisprudence of WTO DSB, one can conclude that the method qualitatively summarizes the systematic interactions of articles of WTO agreements.

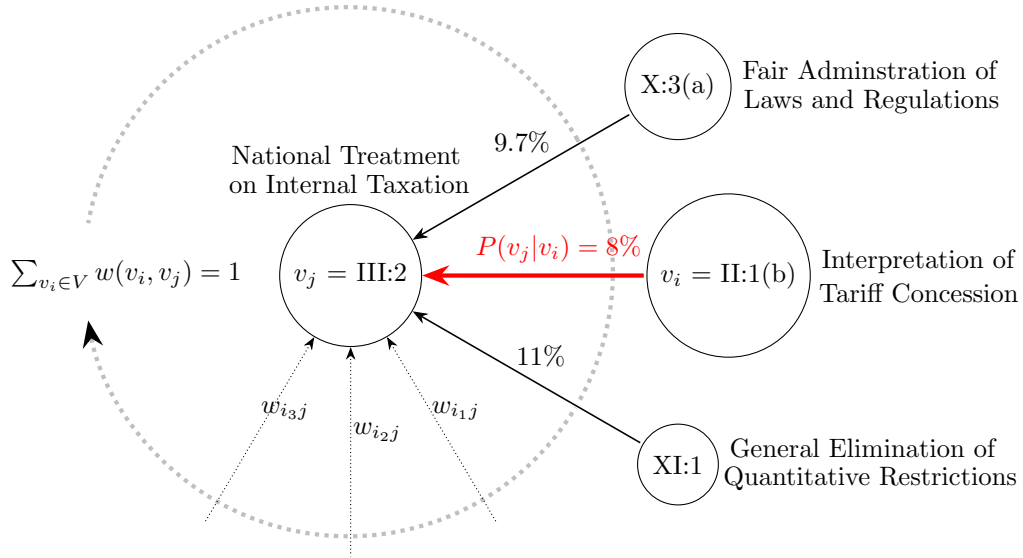
2 Modeling and Formal Definitions

2.1 Network of Articles of the WTO agreements

I define the network of articles of WTO agreements as directed weighted graph $G = (V, \vec{E}, W)$ which is comprised of vertex set V , set of directed edges \vec{E} , and edge weight matrix W . I define each legal article of WTO agreement as a vertex, thus $V = \{v \mid v \text{ is a legal article of WTO agreement}\}$. Then I define all ordered pairs of vertices as a set of directed edges \vec{E} , thus $\vec{E} = \{(v_i, v_j) \mid (v_i, v_j) \in V \times V\}$. Finally, I define the edge weight matrix $W = (w(v_i, v_j)) \in [0, 1]^{|V| \times |V|}$ where all incoming edge weights sum up to 1 for all given target vertex v_j , thus $\sum_{v_i \in V} w(v_i, v_j) = 1$. w denotes a map that assigns a weight for each ordered pair of vertices, thus $w : V \times V \rightarrow [0, 1]$. I always assign weight 0 for the directed edge comprised of the same vertex, thus $w(v_i, v_i) = 0 \ \forall v_i \in V$. For convenience, I define $w_{ij} = w(v_i, v_j)$.

2.2 Modeling of Systematic Interaction between Articles of WTO agreements as Conditional Probability

I defined



(a) Illustrated edge weights of a target node Article III:2

“The dictionary definition of the noun ‘excess’ is ‘[t]he amount by which one number or quantity exceeds another’. More specifically, ‘in excess of’ means ‘more than’. Thus, as a textual matter, a particular number or quantity is ‘in excess of’ another number or quantity if it is greater, regardless of the extent to which it is greater. **Looking at the context of Article II:1(b), first sentence, we note that Article III:2, first sentence, of the GATT 1994 is cast in very similar terms and in fact uses the phrase ‘in excess of’:**

The products of the territory of any contracting party imported into the territory of any other contracting party shall not be subject ... to internal taxes or other internal charges of any kind in excess of those applied ... to like domestic products ...

(b) **Jurisprudence of Panel in *Russia – Tariff Treatment* case:**

Panel clarifies the point that the meaning of the term ‘*in excess of*’ in Article II:1(b) clarifies the meaning of the same phrase in Article III:2.

Figure 1: **Illustration of Network of Legal Articles of WTO agreements:** Every directed edge weight w_{ij} is interpreted as the conditional probability $P(v_j|v_i)$ of how probably a source node v_i constitutes a legal context to clarify the meaning of the target node v_j among all other source nodes $v \in V \setminus \{v_i, v_j\}$. Above subfigure (a) represents how jurisprudence of *Panel* stated in (b) is represented as an edge weight where the source node Article II:1(b) constitutes the legal context of the target node Article III:2 regarding how to interpret its term ‘*in excess of*’ with the 8% of importance compared to other possible source articles.

way of the fitted network G^* explaining how articles of WTO agreements achieve some main principles of WTO, such as *Market Access*, *Reciprocity* and *Non-discrimination*

After fitting W^* , to check whether this fitted network of articles of the WTO agreements $G^* = (V, E, W^*)$ maps the jurisprudences of WTO DSB properly, this paper compares the way of the fitted network G^* explaining how articles of WTO agreements achieve some main principles of WTO, such as *Market Access*, *Reciprocity* and *Non-discrimination* with the jurisprudences of *Panel* and *Appellate Body*. This comparison reveals that the fitted network G^* captures the interactions between the articles of WTO agreements closely to the jurisprudences of *Panel* and *the Appellate Body*. We can infer from this similarity that the fitted network G^* closely maps the jurisprudences of WTO DSB. This is because those two judicial bodies authoritatively constitute the jurisprudences over how rules of WTO agreements are working together to achieve those main principles.

Finally, upon this similarity, this paper offers this methodology as an alternative solution to the widening gap of legal capacity between developing and developed countries in WTO DSB. Since this method effectively materializes the shared understanding of legal experts and reveals important interactions between articles inside the system of WTO DSB, it can lower the cost to build the same amount of legal capacity to understand the WTO DSB. Moreover, rather than keep relying on previous approach that provides legal advice to developing countries that does not create a shared understanding over the system between developing and developed countries, if we shift our focus on how to materialize the current shape of the system, WTO will become more effective as members being able to discuss their trade issues upon the measurable ground of shared understanding about how WTO works.

The legal system of WTO is understood as a complex network of articles of WTO agreements. The articles of WTO agreements interact with each other to constitute specific norms and regulates specific trade issues. There exists a numerous literatures that studies the relationship between articles of WTO agreements (????). However, previous literatures have been limited to study the interconnection between relatively small number of articles, which are mostly less than ten. Since the legal system of WTO comprises

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aims to find out the network of legal articles of WTO agreements as a whole.

This kind of research that studies the relationship between articles of WTO agreements has been actively pursued in numerous literatures (????), however, those efforts has been limited to

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network of interconnection between articles of WTO agreements is exclusively shared among a group of legal experts of the WTO agreements. This exclusiveness becomes more severe as the number of cases requested to WTO DSB increases and this has led to a widening gap of legal capacities between developing and developed countries. This gap now inhibits the effectiveness of the WTO because developing countries are excluded from the WTO DSB to resolve their dissatisfaction over the trade relationship with other members. The legal system of WTO is understood as a complex network of articles of WTO agreements.

This process requires enormous legal knowledge and resources.

A trade dispute tend to involve complex issue structure.

because it requires many legal experts to structure a legal argument with a full understanding of the WTO legal system.

and

The legal system of WTO is understood as a complex network of articles of WTO agreements. Each part of the network constitutes specific norms and regulates specific trade issues.

where each part of network handles each

between articles are constituting specific norms and regulating specific trade issues.

Countries usually cite multiple articles to claim their impaired benefits in WTO DSB.

and the legal system of WTO DSB has evolved into complex network of articles where the interconnectedness between articles are constituting specific norms and regulating specific trade issues.

This process requires enormous legal knowledge and resources because a trade dispute tend to involve several interconnected trade issues.

to handle those trade disputes.

analyzing the network of articles of the WTO agreements provides us a clear view on how WTO DSB constitutes specific norms and regulates specific trade issues.

Therefore, countries tend to cite multiple articles of WTO agreements to claim their impaired benefits in WTO DSB.

Therefore, a lawsuit tends to cite multiple rules of the WTO agreement because one simple rule can't cover the complex characteristics of the trade policy that led to the dispute (?). For example, the United States enacted *Continued Dumping and Subsidy Act of 2000* (CDSOA) that distributes the collected anti-dumping duties to its affected domestic producers. This act was challenged by other members with several rules of the WTO agreements such as *rules of anti-dumping* and *rules of subsidy*. This was because this distribution could constitute an illegal subsidy and illegal

anti-dumping duty at the same time as stated in the Panel report of the *US - Offset (CDSOA)* case

8.1 In the light of our findings, we conclude that **the CDSOA is inconsistent with AD (Anti-dumping) Articles 5.4, 18.1 and 18.4, SCM (Subsidy and Countervailing Measure) Articles 11.4, 32.1 and 32.5**, Articles VI:2 and VI:3 of the GATT 1994, and Article XVI:4 of the WTO Agreement. . . .

8.3 **The CDSOA is a new and complex measure, applied in a complex legal environment.** In concluding that the CDSOA is in violation of the above mentioned provisions, we have been confronted by sensitive issues regarding the use of subsidies as trade remedies. this matter through negotiation.

Since multiple articles cooperate to deal with the real world dispute, analyzing the network of articles of the WTO agreements provides us a clear view on how WTO DSB constitutes specific norms and regulates specific trade issues. This kind of research that studies the relationship between articles of WTO agreements has been actively pursued in numerous literatures (????), however, those efforts has been limited to study interconnectedness between relatively small numbers (less than 10) of articles.

Therefore, this research aims to find out the network of legal articles of WTO agreements as a whole. Currently, the entire map of interconnection between articles of WTO agreements is exclusively shared among a group of legal experts of the WTO agreements. This exclusiveness becomes more severe as the number of cases requested to WTO DSB increases and this has led to a widening gap of legal capacity between developing and developed countries. This gap now inhibits the effectiveness of the WTO because developing countries are excluded from the WTO DSB to resolve their dissatisfaction over the trade relationship with other members.

Therefore, this paper provides a novel method to summarize the network of articles of WTO agreements. This paper maps the jurisprudence of WTO DSB as a network of legal articles as formally defined as

in Figure 2 and illustrated in Figure 1. This is because the rules of the WTO agreements explicitly requires *Panel* or *Appellate Body* to address relevant articles together when they construct its jurisprudence related to the meaning, scope and interpretation of any legal text in the WTO agreements as excerpted in Figure 3. Upon this requirement, judicial bodies cite multiple articles together to identify the complex legal identity of a trade policy at issue as clearly opinionated in Figure ??. In addition to it, judicial bodies cite multiple articles together to guide an way

of interpretation of the rules of the WTO agreements (*See* Figure 1(b)). To develop a proper method that can find a set of directed edge weights W defined in Figure 2 as close to a shared understanding of legal experts, this paper points out two main considerations. First, one need to use information inside a textual description of factual circumstances of the legal dispute and the regulatory contents inside the text of each article of the WTO agreements. Second, one need to generalize the members' strategic citation pattern that is limited to a member-specific political interest. For example, members strategically cite different rules of the WTO agreements to limit or to encourage the third party participation. Since the third party participation can lead to early settlement of the dispute without continuous legal battle, members cite differently according to their intention to settle the case earlier out of court (?). Moreover, members cite articles strategically trying to reshape the legal precedents of WTO DSB in favor of their future interest (??). Upon these two considerations, this paper selects the deep neural network as a technical solution. This is because a deep neural network is empirically known as good at extracting information from text and generalizing the patterns inside data. Therefore, this paper designs a deep neural network (*See* Figure ?? and ??) that processes two different types of textual information. One is textual description of the dispute (*See* an example at Appendix A.1) and the other one is the text of a legal article of the WTO agreements (*See* an example at Figure 4). This design is improvised to mimic the reasoning process of WTO legal practitioners where the legal practitioners read the textual description of factual circumstances of the dispute and imagine applicable regulatory contents of the legal articles while he/she reads that factual description of the case (*See* Figure ??, ?? and ??).

To train this neural network, this paper collected textual description of trade policy that led to the dispute and articles of the WTO agreement cited for each dispute case requested to the WTO DSB from 1995 to 2018 (Total 143 cases. *Check* the list in Appendix A.2). Using this collected data, I trained the neural network by enforcing the neural network to answer correctly whether a given article of the WTO agreements can be cited for the given textual description of trade policy. (*See* Figure ?? and Figure ??).

After training, I fitted a set of directed edge weights W^* that best explains the variance of each article's citabilities that are predicted by the trained deep neural network using a machine learning technique *Random Forests* (??).

After fitting W^* , to check whether this fitted network of articles of the WTO agreements $G^* = (V, E, W^*)$ maps the jurisprudences of WTO DSB properly, this paper compares the way of the fitted network G^* explaining how articles of WTO agreements achieve some main principles

Network of legal articles of WTO agreements is defined as

$$\text{directed weighted graph } G = (V, E, W)$$

where *vertex set* $V = \{v \mid v \text{ is a legal article of WTO agreement}\}$,

set of directed edges $\vec{E} = \{(v_i, v_j) \mid (v_i, v_j) \in V \times V\}$ and

$$w : V \times V \rightarrow \mathbb{R}_+ \text{ s.t. } w(v_j, v_j) = 0 \text{ and } \sum_{v_i \in V} w(v_i, v_j) = 1 \forall v_j \in V$$

Then define *edge weight matrix* $W = (w_{ij}) \in \mathbb{R}_+^{|V| \times |V|}$ s.t. $w_{ij} = w(v_i, v_j)$

(W is more formally called *weighted adjacency matrix*)

Figure 2: Formal Definition of Network of Legal Articles of WTO agreements: I define network of legal articles of WTO agreements as a directed weighted graph where the sum of all weights coming into a node sum up to 1. w_{ij} is interpreted as conditional probability $P(v_j|v_i)$ how probably a source node v_i clarifies the meaning of the target node v_j compared to other source nodes as illustrated in Figure 1

of WTO, such as *Market Access*, *Reciprocity* and *Non-discrimination* with the jurisprudences of *Panel* and *Appellate Body*. This comparison reveals that the fitted network G^* captures the interactions between the articles of WTO agreements closely to the jurisprudences of *Panel* and *the Appellate Body*. We can infer from this similarity that the fitted network G^* closely maps the jurisprudences of WTO DSB. This is because those two judicial bodies authoritatively constitute the jurisprudences over how rules of WTO agreements are working together to achieve those main principles.

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Article 7

Terms of Reference of Panels

1. Panels shall have the following terms of reference unless the parties to the dispute agree otherwise within 20 days from the establishment of the panel:

“To examine, **in the light of the relevant provisions** in (name of the covered agreement(s) cited by the parties to the dispute), the matter referred to the DSB by (name of party) in document . . . and to make such findings as will assist the DSB in making the recommendations or in giving the rulings provided for in that/those agreement(s).”

2. **Panels shall address the relevant provisions** in any covered agreement or agreements cited by the parties to the dispute. . . .

Figure 3: **Explicit Requirement of Interconnecting Articles of WTO agreements:** Dispute Settlement Understanding (DSU) provides a legal guidelines on how judicial bodies of WTO DSB shall adjudicate the requested disputes. It explicitly requires judicial bodies to interweave relevant articles of the WTO agreements to clarify it’s meaning, scope and interpretation.

Article I

General Most-Favoured-Nation Treatment

1. With respect to customs duties and charges of any kind imposed on or in connection with importation or exportation or imposed on the international transfer of payments for imports or exports, and with respect to the method of levying such duties and charges, and with respect to all rules and formalities in connection with importation and exportation, and with respect to all matters referred to in paragraphs 2 and 4 of Article III, any advantage, favour, privilege or immunity granted by any contracting party to any product originating in or destined for any other country shall be accorded immediately and unconditionally to the like product originating in or destined for the territories of all other contracting parties...

Figure 4: **Example of a legal article of the WTO agreements:** Article I:1 of General Agreement on Tariffs and Trade 1994 that prohibits the discrimination between members of WTO.