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 (World Trade Organization, 2017).

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 (Busch and Shaffer, 2009; Busch and Reinhardt, 2003; SHAFFER, 2006).

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 (Johns and Pelc, 2014) or to reshape the legal precedents(Pelc, 2014; Strezhnev, 2014), 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* (Breiman, 2001; Huynh-Thu et al., 2010). 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 $w : V \times V \to [0, 1]$. 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 $w_{ij} = w(v_i, v_j)$.
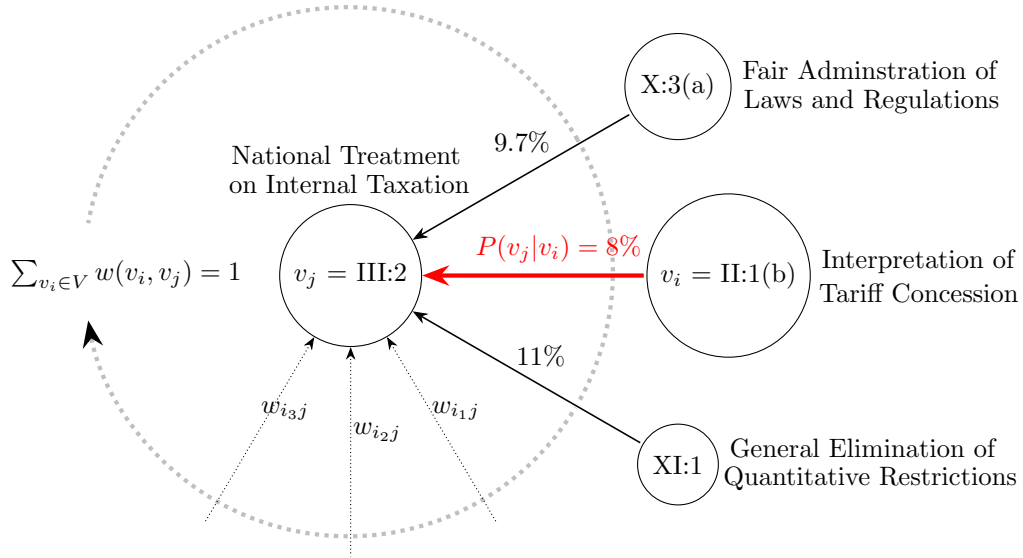
(a) **Illustration of $P(v_j \mid v_i)$ where the target article $v_j =$ Article III:2**

"The dictionary definition of the noun 'excess' is 'the 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 explains 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: **Modeling of the Network of Articles of WTO agreements**

2.2 Modeling Interaction between Articles of WTO agreements as Conditional Probability

I interpret every directed edge weight $w(v_i, v_j)$ as the conditional probability $P(v_j|v_i) \in [0,1]$, where the probability represents how probably the source node v_i clarifies the interpretation of the target node v_j comapred to all other source nodes $v \in V \setminus \{v_i, v_j\}$. The articles of WTO agreements interdependently constitute the legal context to clarify the interpretation of other articles as shown in the the Panel report of *Russia-Tariff Treatment* case, as excerpted in Figure 1(b). In *Russia-*

Tariff Treatment case, the Panel explained that Article II:1(b) clarifies the meaning of the same phrase *'in excess of'* in Article III:2. By modeling this clarification relationship as the directed edge weight w_{ij}, I let the edge weight w_{ij} represent the realtive importance of a source article v_i clarifying the interpretation of the target article v_j. I illustrated this relationship in Figure 1(a).

2.3 Methodological Objective: Finding G^*

I aim to find $G^* = (V, \vec{E}, W^*)$ where the W^* closely reflect the clarification relationship between articles of WTO agreements as explained by the authoritative judicial bodies of the WTO DSB, Panel and Appellate Body. To find W^*, this paper collected the past 20 years of legal dispute data in WTO DSB. The types and composition of the data collected will be explained in Section 3. Then I design a deep neural network to encode the pattern of interactions of the articles of WTO agreements found in the data. Justification of using deep learning, design and training of deep neural network, and fitting process of W^* using *Random Forest* will be explained in Section 4. Finally in Section 5, I will verify the quality of the fitted G^* by comparing the systematic interaction between articles of WTO agreements found in G^* with the corresponding jurisprudence of the Panel and Appellate Body.

3 Data: Types, Composition and Collection Process

3.1 Overview: How Members Raise Claims in WTO DSB

As explained in the introduction, a trade policy that led to a dispute (preferably called as *Government Measure* in WTO DSB) is pretty much complicated as explicitly expressed by the Panel in Figure **??**. To address this complexity, members who raise the claim (preferably called *complainant* in WTO DSB) usually cite multiple articles of the WTO agreements at the same time. For example, in the *US - Offset* case, a group of complainants[1] cited articles as shown in Table 1 from the WTO agreements to claim its inconsistencies of *Continued Dumping and Subsidy Act of 2000* (CDSOA) to those cited articles[2]:

Upon this understanding, I collected two different types of data for 143 different dispute cases

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[1] Australia, Brazil, Chile, European Communities, India, Indonesia, Japan, Korea and Thailand

[2] It is worth noting that the WTO agreements comprises many different agreements covering each specific topic in trade such as *Agreement on Anti-dumping, Agreement on Subsidies and Countervailing Measures, Agreement on Agriculture* and so on.

Name of WTO Agreement	Cited Articles
Agreement on Anti-dumping	1, 5.4, 8, 18.1, 18.4
General Agreement on Tariffs and Trade 1994	VI:3, X:3, XXIII:1, VI:2
Agreement on Subsidies and Countervailing Measures	4.10, 7.9, 10, 11.4, 18, 32.1, 32.5
Agreement Establishing the World Trade Organization	XVI:4

Table 1: Cited articles in *US - Offset (Byrd Amendment)* by complainants

requested to WTO DSB. (List of cases is available at Appendix A.2). One is textual description of the dispute (*Check* the CDSOA example at Appendix A.1) and the other one is set of articles of the WTO agreements that are cited for each dispute (Appendix A.3). I will explain the data source, structure and collection method for two different types of data at the following subsections.

Figure 2: **Table of Contents of Panel Report:** Panel provides factual aspect in the panel report with its page location.

3.2 Factual Aspect: Textual Description of the Dispute

Textual description of the dispute is preferably called as *Factual Aspect* in WTO DSB. Since Panels always provide a factual aspect[3] that summarizes the content of the dispute in the panel report, I wrote a program that can automatically search and collect the panel reports from the WTO

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[3]It's worth noting that Appellate Body doesn't provide any factual aspect because they always use the factual aspect provided by the Panel.

official document website[4]. Then I located the factual aspect using the page information inside the table of contents in the panel report as shown in Figure 2. By using this location, I excerpted 143 numbers of different factual aspects from the same number of different panel reports. The case numbers are listed in Figure 3.

3.2.1 Joint Adjudication & Early Settlement

The number 143 seems small compared to the total 596[5] number of cases that are requested to WTO DSB. This is due to the following two reasons. First, panel handles different cases together if the case is about the same trade policy. For example, in *US - Offset (Byrd Amendment)*, panel merged DS217[6] and DS234 together because they were asking the judicial opinion for the same government measure of the United States as shown in Figure 4. This paper selects the smallest case number as a representative number for this case of joint adjudication. For example, DS217 and DS234 share the same panel report then this paper chooses DS217 as a representative number as shown in Figure 3 where the list includes DS217 but not DS234. Second, members sometimes find *mutually agreeable solution* before the panel expresses its judicial opinion by publishing its panel report. Then Panel stops there and no factual aspect is provided. This paper omitted this kind of *early settled* cases as well.

> DS 2, 18, 22, 31, 34, 46, 56, 58, 60, 62, 67, 68, 69, 75, 76, 87, 90, 98, 103, 108, 121, 122, 135, 136, 139, 141, 146, 152, 155, 161, 162, 165, 166, 174, 175, 177, 184, 202, 207, 212, 217, 219, 221, 231, 234, 238, 244, 245, 246, 248, 257, 264, 265, 266, 267, 268, 269, 276, 282, 283, 286, 290, 294, 295, 296, 301, 302, 308, 312, 315, 316, 320, 321, 322, 332, 336, 339, 343, 344, 345, 350, 353, 360, 363, 366, 371, 379, 381, 384, 392, 394, 396, 397, 399, 400, 406, 412, 414, 415, 422, 425, 427, 429, 430, 431, 435, 436, 437, 440, 442, 447, 449, 453, 454, 456, 457, 461, 464, 468, 471, 472, 473, 475, 476, 477, 479, 480, 482, 483, 484, 485, 486, 488, 490, 492, 493, 495, 499, 504, 505, 513, 518, 523

Figure 3: **List of case number of collected panel reports:** "DS + number" uniquely identifies each dispute. For example, DS 523 refers to *US — Pipe and Tube Products (Turkey)* where the United States was challenged by Turkey for its possibly inconsistent anti-dumping measure.

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[4]http://docs.wto.org
[5]As of November 1st, 2020.
[6]DS refers to *Dispute Settelement*. DS is the official prefix that indicates the case in WTO DSB.

UNITED STATES – CONTINUED DUMPING AND SUBSIDY
OFFSET ACT OF 2000

Report of the Panel

Figure 4: **Cover of a Panel Report Includes Information about Joint Adjudication:**
Panel explicitly marks which different cases are handled together in the cover of the panel report.
DS217 and DS234 are handled together in this example.

3.3   Cited Articles: Set of Articles Cited for the Same Dispute

Every lawsuit in WTO DSB cites multiple set of articles as shown in Table 1. To collect this set of articles claimed for the same dispute, I wrote a program that collects this set of articles cited for the same dispute from the WTO official webpage[7]. The webpage chronologically lists up all dispute cases requested to WTO DSB and the program visits each page of 143 cases and collects the cited articles. Among all the agreements included in the WTO agreements[8] as a component, this paper collected articles from **General Agreement on Tariffs and Trade 1994 (GATT 1994)** only. This is because articles in GATT 1994 constitutes basic set of trade rules of WTO and other agreements elaborates the articles of GATT 1994 more in detail (World Trade Organization, 1999). For example, the official name of *Agreement on Anti-dumping* is *Agreement on Implementation of* **Article VI of the GATT 1994** where the name self-explains that it elaborates on the article VI of GATT 1994. The collected result is listed in the Appendix A.2. Figure 5 lists up 80 different

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[7]https://www.wto.org/english/tratop_e/dispu_e/dispu_status_e.htm

[8]WTO agreements is comprised of multiple agreements, such as General Agreement on Tariffs and Trade 1994, Agreement on Agriculture, Agreement on the Application of Sanitary and Phytosanitary Measures, Agreement on Textiles and Clothing, Agreement on Technical Barriers to Trade, Agreement on Trade-Related Investment Measures, Agreement on Implementation of Article VI of the General Agreement on Tariffs and Trade 1994 (antidumping), Agreement on Subsidies and Countervailing Measures, Agreement on Rules of Origin, Agreement on Safeguards and so on.

articles of GATT 1994 cited in 143 cases without duplication.

> I, I:1, II, II:1, II:1(a), II:1(b), II:2, II:3, III, III:1, III:2, III:4, III:5, III:7, IV, IX, IX:2, V, V:1, V:2, V:3, V:3(a), V:4, V:5, V:6, V:7, VI, VI:1, VI:1(a), VI:1(b), VI:2, VI:3, VI:5(a), VI:6, VII, VII:1, VII:2, VII:5, VIII, VIII:1, VIII:3, VIII:4, X, X:1, X:2, X:3, X:3(a), XI, XI:1, XIII, XIII:1, XIII:2, XIII:3(b), XIX, XIX:1, XIX:2, XIX:3, XV, XVI, XVI:1, XVI:4, XVII, XVII:1, XVII:1(c), XVIII, XVIII:10, XVIII:11, XX, XXI, XXII, XXII:1, XXIII, XXIII:1, XXIII:1(a), XXIII:1(b), XXIV, XXIV:12, XXIV:5(b), XXIV:6, XXVIII

Figure 5: **Set of articles of GATT 1994 collected and used in this paper:** These articles comprises the node set V and their ordered pairs comprise the edge set E in Figure **??**

$$\text{Let } D \text{ is a set of DS case numbers listed in Figure 3.}$$
$$\text{Then there exists } c_d = \{v_d \in V \mid v_d \text{ is an article cited in the case } d \in D\}$$
$$\text{where } V \text{ is set of articles listed in Figure 5.}$$
$$\text{Then define set of cited articles } C = \{c_d \mid d \in D\}$$

Figure 6: **Formal Definition of Set of Cited Articles:** I formally define a set of cited articles C and the elements of C are listed in Appendix A.2.

3.3.1 Various Levels of Scope in Cited Articles

As shown in Figure 5, members sometimes cite articles in different levels of scope. For example, For the Article II, member sometimes cites Article II as a whole but sometimes cites Article II:1 or Article II:1(a). This is because two main judicial bodies of WTO DSB, *Panel and Appellate Body*, both constitute its legal precedents citing articles of the WTO agreements in various levels of scope. Those judicial bodies cite the articles with the level of various scopes, such as *Title, Article, Paragraph, Sentence* or *Term* as shown in Table 2. Following this jurisprudence, members also cite articles in different levels of scope to make their legal claim fit and valid according to the current jurisprudences of WTO DSB.

Table 2: **Various Levels of Scope Adopted to Cite Articles of WTO agreemnts**

Scope	Quote	Source

Title	"As the ***title* of Article 21 makes clear**, the task of panels . . . forms part of the process of the 'Surveillance of Implementation of the Recommendations and Rulings' of the DSB. . . ."	Appellate Body Report, *US – Shrimp (Malaysia)*, paras. 86-87.
Article	"The sequence of steps indicated above in the analysis of a claim of justification under **Article XX** reflects, not inadvertence or random choice, but rather the fundamental structure and logic of Article XX. . . ."	Appellate Body Report, *US – Shrimp (Malaysia)*, paras. 119-120.
Paragraph	"The verb 'may' in **Article VI:2** of the GATT 1994 is, in our opinion, properly understood as giving Members a choice between imposing an anti-dumping duty or not, as well as a choice between imposing an anti-dumping duty equal to the dumping margin or imposing a lower duty. . . ."	Appellate Body Report, *US – 1916 Act*, paras. 116.
Sentence	"The customary rules of interpretation of public international law as required by **the first sentence of Article 17.6(ii) of the Anti-Dumping Agreement**, do not admit of another interpretation as far as the issue of zeroing raised in this appeal is concerned."	Appellate Body Report, *US – Zeroing (EC)*, paras. 132-133.

| Term | "Article II:1(a) provides that a Member shall accord to the 'commerce' of other Members treatment no less favourable than that provided for in its Schedule. **The term 'commerce'** is defined as referring broadly to the exchange of goods such that, in this provision, the 'commerce' of a Member should be understood to refer to all such exchanges of that Member" | Appellate Body Report, *Colombia – Textiles*, para. 5.34. |

4 Methodology: Considerations and Development

This section introduces two main considerations that are taken to design the method used in this paper. Those considerations justify the use of the deep neural network. Then I explain the detailed structure of the deep neural network and its training schemes. After finishing training of the neural network, I explain the process that I conducted to fit the network of articles using Random Forest.

5 Empirical Findings

This section verifies how well the fitted network $G^* = (V, E, W^*)$ aligns with the jurisprudences of the *Panel* or *Appellate Body* of WTO DSB. Since these two judicial bodies of WTO DSB authoritatively opinionate how the regulatory system of WTO DSB systematically organized, this section will validate the quality of the fitted network G^* by introducing three different sub-networks of the fitted network G^* where each sub-network shows how articles of WTO agreements cooperatively achieves important principles of WTO and regulates specific trade issues.

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