Classification of Contractual Conflicts via Learning of Semantic Representations

Extended Abstract

João Paulo Aires, Roger Granada, Juarez Monteiro, Rodrigo Coelho Barros and Felipe Meneguzzi
Pontifical Catholic University of Rio Grande do Sul, Porto Alegre, Brazil
{joao.aires.001, roger.granada, juarez.santos}@acad.pucrs.br {rodrigo.barros, felipe.meneguzzi}@pucrs.br

ABSTRACT

Contracts are the main medium through which parties formalize their trade relations, be they the exchange of goods or the specification of mutual obligations. While electronic contracts allow automated processes to verify their correctness, most agreements in the real world are still written in natural language, which need substantial human revision effort to eliminate possible conflicting statements in long and complex contracts. In this paper, we formalize a typology of conflict types between clauses suitable for machine learning and develop techniques to review contracts by learning to identify and classify such conflicts, facilitating the task of contract revision. We evaluate the effectiveness of our techniques using a manually annotated contract conflict corpus with results close to the current state-of-the-art for conflict identification, while introducing a more complex classification task of such conflicts for which our method surpasses the state-of-the art method.

KEYWORDS

Natural Language Processing; Norms; Norm Conflicts; Semantic Representation

ACM Reference Format:

João Paulo Aires, Roger Granada, Juarez Monteiro, Rodrigo Coelho Barros and Felipe Meneguzzi . 2019. Classification of Contractual Conflicts via Learning of Semantic Representations. In *Proc. of the 18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019), Montreal, Canada, May 13–17, 2019,* IFAAMAS, 3 pages.

1 INTRODUCTION

Most societies use contracts as a central tool to formalize agreements [18], often dealing with the exchange of a service or goods offered by a creditor and paid by a debtor [9, 13]. Contracts are semi-structured documents that describe the agreement subject, its parties, and a series of definitions of what is expected from each party during the agreement validation. Researchers in norm-driven reasoning [15] often formalize clauses in contracts in terms of norms [11] indicating the involved parties, a deontic meaning (obligation, prohibition, or permission), and an action to be performed (the object of the norm). Contracts tend to be long and complex to maximize coverage of situations that could arise out of an agreement [12]. Such complexity invariably leads to the danger of logical contradictions between the norms described in natural language, which in turn leads to norm conflicts. Norm conflicts are often the result of a clash between specifications, *i.e.*, something expressed in one norm makes impossible to comply with another one [8], and may invalidate a contract.

We address the problem of automatically identifying and classifying potential conflicts between norms in contracts. In order to do so, we first define four types of norm conflicts based on existing definitions of conflict types that involve the differences in deontic meaning and norm structure of a contractual clause. Second, we extend an existing corpus [3] with norm conflicts by adding different conflict types. This addition allows us to identify complex conflicting cases involving small differences on norm structures and conditional terms. Third, we develop a number of approaches based on sentence embeddings to detect and classify norm conflicts according to the conflict typology. We evaluate the resulting approach empirically and show that our results surpass the current state of the art approach for classifying conflicts in contracts.

2 NORM CONFLICT TYPES

While there are various typologies for norm conflicts [6, 14, 17, 20], in the specific case of conflicts in contracts, one specific typology stands out by relating the *deontic representation* of norms within clauses to the possible types of conflicts [21]. However, in order to diagnose the specific nature of the conflict and amend clauses to eliminate them, contract writers often need more information than the deontic modalities of two clauses are in conflict. Thus, we leverage the typology of Sadat-Akhavi [19] to identify four conflict types that can facilitate the task of eliminating existing conflicts by finely defining the *nature* of the conflicts. The four types are: *deontic-modality*, *deontic-structure*, *deontic-object*, and *object-conditional*.

The *deontic-modality* type indicates the simplest conflict case, where conflicts only occur when two norms conflict primarily because of the deontic statement in them, *i.e.*, prohibition × obligation, obligation × permission, and permission × prohibition. *deontic-structure* conflicts are similar to *deontic-modality* conflicts in that they involve two norms with different deontic meanings and a different structure. By structure, we mean the way a norm is expressed in natural language. In this case, they can describe the same subject using different expressions. The *deontic-object* conflict type indicates cases where both norms have the same deontic meaning but different overall structures. In this particular case, a conflict arises due to the definitions of the norm actions and specification details. Finally, the *object-conditional* conflict type occurs between a pair of norms when the action defined in a condition or exception conflicts with the definition of a second norm. This type concerns specific examples where a condition is involved.

Proc. of the 18th International Conference on Autonomous Agents and Multiagent Systems (AAMAS 2019), N. Agmon, M. E. Taylor, E. Elkind, M. Veloso (eds.), May 13–17, 2019, Montreal, Canada.

3 DATASET EXTENSION

The dataset [4] we use in our experiments consists of an extended version of an existing contract conflict dataset from Aires et al. [3]. In order to extend the dataset, we developed a web-based tool[1] that randomly selects norms within the contract corpus and creates a copy of the norm, instructing a human volunteer to edit the norm in such a way as to create a conflict with the original norm. The web tool instructed volunteers to introduce new conflicts following one of the types described earlier in the paper, but providing no further instructions on how to actually write the new conflict. By deliberately inserting conflicts into the contract we ensure that the new contract has a conflicting pair of norms in it. The resulting dataset contains a total of 228 conflicting norms including the existing 111 conflicts from the previous dataset in addition to a total of 11,329 non-conflicting sentence pairs.

4 CONFLICT IDENTIFICATION AND CLASSIFICATION

We develop two approaches for norm conflict identification, *i.e.*, classify unseen pairs of norms as conflict or non-conflict, and two further approaches to classify the *type* of conflict that occurs between norm pairs (*deontic-modality*, *deontic-structure*, *deontic-object*, or *object-conditional*). Before identifying or classifying norms, we transform each norm written in natural language within a contract into a vector representation using sent2Vec [10, 16].

For conflict identification, we compute the distance between norm embeddings (E_n) and use these distances as a semantic representation of the presence or absence of norm conflicts (*i.e.*, conflicts and non-conflicts). In a first approach, we identify the centroid of concatenated embeddings (E_{conc}) of norm pairs representing conflicts and the centroid of concatenated embeddings representing non-conflicts. We generate the centroid (E_{cent}) by computing the mean of this extended embedding space. In a second approach, we compute two centroids for the offset embeddings (E_{off}) of norm pairs. In order to identify a conflict, we calculate the distance between the comparative embedding (either E_{off} or E_{conc}) of the norm pair and the center of the embeddings (E_{cent}) representing conflicts. Finally, the pair of norms is identified as conflict if the distance to the centroid representing conflicts is smaller than the distance to the centroid representing non-conflicts. We also perform conflict identification by training a Support Vector Machine [7] (SVM) using either the concatenation E_{conc} or the offset E_{off} of embeddings representing pairs of norms.

In this *conflict classification* we want to classify the *type of conflict* (*deontic-modality*, *deontic-structure*, *deontic-object*, and *object-conditional*) between a conflicting norm pair, unlike conflict identification. Therefore, we use an SVM with five classes (four conflicts and a non-conflict class) containing either the concatenation E_{conc} or the offset E_{off} of embeddings representing pairs of norms. Due to the unbalanced nature of the dataset, we remove the non-conflicting pairs of norms and test the performance of an SVM classifier when trying to divide only conflicting pairs of norms. Thus, this approach classifies the type of conflict (*deontic-modality*, *deontic-structure*, *deontic-object*, or *object-conditional*) of an unseen pairs of norms.

[1] Available at http://lsa.pucrs.br/concon/

5 EXPERIMENTS AND RESULTS

As the dataset contains a much larger number of non-conflicting pairs of norms when compared to the number of conflicting pairs of norms, we randomly select a subset of the non-conflicting norm pairs for training to avoid biasing the model towards classifying norm pairs as non-conflicting. We measure the performance of our approaches and related work using the test of our new conflict dataset. In our experiments, we perform experiments for the conflict identification (CI) task using the distance (*CI-Distance*) between the concatenated E_n of unseen pair of norms and the concatenated E_{cent} of conflicts and non-conflicts, and using an SVM classifier (*CI-SVM*) trained with the concatenation of E_n representing conflicting and non-conflicting norms. For conflict classification (CC), we perform experiments using both non-conflict and the four types of conflicts (*CC-All*), and using only the four types of conflicting norms (*CC-Conf*), where embeddings are generated by the concatenation of each norm pair (E_{conc}). We compare our approaches against the ones by Aires and Meneguzzi [2] and Aires et al. [1]. Since Aires et al. [1] use a single offset vector to identify conflicts, we can only compare in the conflict identification task.

Table 1: Performance summary, where 'CI' denotes Conflict Identification and 'CC' denotes Conflict Classification.

Approach	$\mathcal{A}$	$\mathcal{P}$	$\mathcal{R}$	$\mathcal{F}$
CI-Distance	0.65	0.61	0.72	0.67
CI-SVM	0.78	0.77	0.77	0.77
CI–Aires *et al.* [2]	**0.83**	0.87	**0.83**	**0.85**
CI–Aires *et al.* [1]	0.74	**0.98**	0.48	0.63
CC-All	0.70	0.71	0.64	0.66
CC-Conf	**0.77**	**0.75**	**0.78**	**0.72**
CC–Aires *et al.* [2]	0.63	0.59	0.64	0.61

6 CONCLUSION

We developed multiple approaches to identify and classify conflicts between norms in contracts [5][2]. Our approaches consist of manipulations on embedding representations of norms in order to identify conflicts. We test multiple comparative embeddings as input to train an SVM for both identification and classification. As part of our contribution, we propose four conflict types to classify a conflict and help contract designers solving such conflicts. We extend an existing norm conflict corpus adding the new types and use it to train our classifiers. Compared to existing approaches, we obtain results that surpass the state of the art approach for the classification tasks and are competitive with it for conflict identification. Such result shows that using comparative embeddings is an effective method to identify complex norm conflicts.

Acknowledgement. This study was financed in part by the CAPES - Finance Code 001, and CAPES/FAPERGS agreement (DOCFIX 04/2018). We gratefully acknowledge the support of NVIDIA Corporation with the donation of the Titan Xp GPU used for this research. We thank Google Research Awards for Latin America for funding part of our project.

[2] Available at https://github.com/mir-pucrs/norm-conflict-classification

REFERENCES

[1] João Paulo Aires, Roger Granada, Juarez Monteiro, and Felipe Meneguzzi. 2018. Norm Conflict Identification using Vector Space Offsets. In *Proceedings of the 2018 International Joint Conference on Neural Networks (IJCNN'18)*. IEEE, Washington, DC, USA, 337–344.

[2] João Paulo Aires and Felipe Meneguzzi. 2017. Norm Conflict Identification Using Deep Learning. In *AAMAS'17 Workshop on Coordination, Organisation, Institutions and Norms in Multi-Agent Systems (COIN 2017)*. Springer International Publishing, 194–207.

[3] João Paulo Aires, Daniele Pinheiro, and Felipe Meneguzzi. 2017. Norm Dataset: Dataset with Norms and Norm Conflicts. (March 2017). https://doi.org/10.5281/zenodo.345411

[4] João Paulo Aires, Roger Granada, and Felipe Meneguzzi. 2019. Dataset with Classified Norm Conflicts. (Feb. 2019). https://doi.org/10.5281/zenodo.2566051

[5] João Paulo Aires, Roger Granada, and Felipe Meneguzzi. 2019. Norm Conflict Classifier. (Feb. 2019). https://doi.org/10.5281/zenodo.2566097

[6] Carlos E Alchourrón. 1991. Conflicts of norms and the revision of normative systems. *Law and Philosophy* 10, 4 (1991), 413–425.

[7] Koby Crammer and Yoram Singer. 2001. On the Algorithmic Implementation of Multiclass Kernel-based Vector Machines. *Journal of Machine Learning Research* 2, Dec (2001), 265–292.

[8] A.A.O. Elhag, J.A.P.J. Breuker, and P.W. Brouwer. 2000. On the Formal Analysis of Normative Conflicts. *Information & Communications Technology Law* 9, 3 (2000), 207–217.

[9] Oliver Hart and Bengt Holmström. 1987. *The Theory of Contracts*. Cambridge University Press, 71–156.

[10] Armand Joulin, Edouard Grave, Piotr Bojanowski, Matthijs Douze, Hérve Jégou, and Tomas Mikolov. 2016. FastText.zip: Compressing Text Classification Models. *arXiv preprint arXiv:1612.03651* (2016).

[11] Michael Luck, Samhar Mahmoud, Felipe Meneguzzi, Martin Kollingbaum, Timothy J. Norman, Natalia Criado, and Moser Silva Fagundes. 2013. Normative Agents. In *Agreement Technologies*, Sascha Ossowski (Ed.). Law, Governance and Technology Series, Vol. 8. Springer Netherlands, 209–220.

[12] Felipe Meneguzzi, Sanjay Modgil, Nir Oren, Simon Miles, Michael Luck, and Noura Faci. 2012. Applying electronic contracting to the aerospace aftercare domain. *Engineering Applications of Artificial Intelligence* 25, 7 (2012), 1471–1487. http://www.sciencedirect.com/science/article/pii/S0952197612001479

[13] Felipe Meneguzzi, Pankaj R. Telang, and Munindar P. Singh. 2013. A First-Order Formalization of Commitments and Goals for Planning. In *Proceedings of the Twenty-Seventh AAAI Conference on Artificial Intelligence*. 697–703.

[14] Nikos Nikiforakis, Charles N Noussair, and Tom Wilkening. 2012. Normative conflict and feuds: The limits of self-enforcement. *Journal of Public Economics* 96, 9-10 (2012), 797–807.

[15] Jean Oh, Felipe Meneguzzi, Katia Sycara, and Timothy J. Norman. 2013. Prognostic normative reasoning. *Engineering Applications of Artificial Intelligence* 26, 2 (2013), 863 – 872. https://doi.org/10.1016/j.engappai.2012.12.006

[16] Matteo Pagliardini, Prakhar Gupta, and Martin Jaggi. 2018. Unsupervised Learning of Sentence Embeddings Using Compositional n-Gram Features. In *Proceedings of the 2018 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies (NAACL-HLT 2018)*. Association for Computational Linguistics, 528–540.

[17] Heiko Rauhut and Fabian Winter. 2017. Types of Normative Conflicts and the Effectiveness of Punishment. *Social dilemmas, institutions, and the evolution of cooperation* (2017), 239.

[18] Denise M. Rousseau and Judi M. Parks. 1993. The Contracts of Individuals and Organizations. *Research in Organizational Behavior* 15 (Jan. 1993), 1–43.

[19] Seyed-Ali Sadat-Akhavi. 2003. *Methods of Resolving Conflicts Between Treaties*. Graduate Institute of International and Development Studies, Vol. 3. Martinus Nijhoff Publishers.

[20] Wamberto W. Vasconcelos, Martin J. Kollingbaum, and Timothy J. Norman. 2009. Normative conflict resolution in multi-agent systems. *Autonomous Agents and Multi-Agent Systems* 19, 2 (2009), 124–152.

[21] Erich Vranes. 2006. The Definition of 'Norm Conflict' in International Law and Legal Theory. *European Journal of International Law* 17, 2 (2006), 395–418.