TOWARDS SEMI-AUTOMATIC MODEL SPECIFICATION

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ABSTRACT

This paper presents a natural language understanding (NLU) approach to transition a description of a phenomenon towards a simulation specification. As multidisciplinary endeavors using simulations increase, the need for teams to better communicate and make non-modelers active participants on the process increases. We focus on semi-automating the model conceptualization process towards the creation of a specification as it is one of the most challenging steps in collaborations. The approach relies on NLU processing of narratives, creates a model that captures concepts and relationships, and finally provides a simulation implementation specification. An initial definition set and grammatical rules are proposed to formalize this process. A Design of Experiments was used to test the NLU model accuracy for a test case that generates Agent-Based Model (ABM) conceptualizations and specifications. We provide a discussion on the advantages and limitations of using NLUs for model conceptualization and specification processes.

1 INTRODUCTION

Model development is an iterative process that often takes place between non-modelers (people interested in a modeling solution) and modelers (people providing a modeling solution). In this process, competing worldviews, knowledge level, and means of expression lead to ambiguous interpretations and frustrations among participants resulting in breaks in communication and engagement. Domain experts have diverse forms of expression characterized by variations in semantic depth and worldviews that compete with the modeling specialist's interpretation of these expressions and methods. It is the modeling specialist that is required to interpret the expert's expressed perception in order to facilitate model development. Unfortunately, this introduces the potential for ambiguities and inconsistencies that must be resolved in order to ensure models fulfill their objectives and the team is not decimated. We posit that natural language processing-based tools can bridge the gap by allowing non-modelers to create models.

2 APPROACH

This research applies an approach that extends the work described by Padilla et al. (2019) where agents, attributes, and rules were extracted from a narrative to form an ABM, but the research did not address relationships between concepts. Further refinement is also achieved by following a stricter grammatical ruleset that dictates more consistent corpus annotations for semi-supervised training.

3 RESULTS

Experiments are designed to assess the performance of the NLU model by varying the number of training and test cases. The primary metrics are precision, recall, and the F1 score. A subset of the experiment results is shown in Tables 1 and 2. Given the relatively small training and testing set, the results are promising that an NLU is able to accurately propose ABM elements.

Table 1: Agents, attributes, and rules results from an experiment.

Exp ID	Documents		Agents			Attributes			Rules		
	Train	Test	F1	Prec.	Recall	F1	Prec.	Recal	F1	Prec.	Recall
3	20	5	0.70	0.83	0.60	0.60	0.65	0.56	0.50	0.59	0.43
4	25	5	0.69	0.78	0.61	0.55	0.55	0.54	0.51	0.53	0.49
5	30	5	0.70	0.73	0.67	0.57	0.57	0.57	0.49	0.52	0.47

Table 2: Relationship results from an experiment.

Exp ID	Documents		Agent-Attribute			Agent-Rule			Rule-Agent		
	Train	Test	F1	Prec.	Recall	F1	Prec.	Recal	F1	Prec.	Recall
3	20	5	0.54	0.64	0.47	0.38	0.45	0.33	0.32	0.56	0.23
4	25	5	0.45	0.47	0.44	0.36	0.36	0.37	0.33	0.45	0.26
5	30	5	0.47	0.45	0.49	0.36	0.35	0.37	0.33	0.45	0.26

A candidate sentence was subjected to the NLU model, and the extracted ABM elements are shown in Figure 1. As shown in the figure, the NLU model is able to annotate sentence elements as ABM-specific elements. However, in this particular example, we notice that there is some mis-characterization such as assigning the word, *slower*, to the ABM element, *agent*.
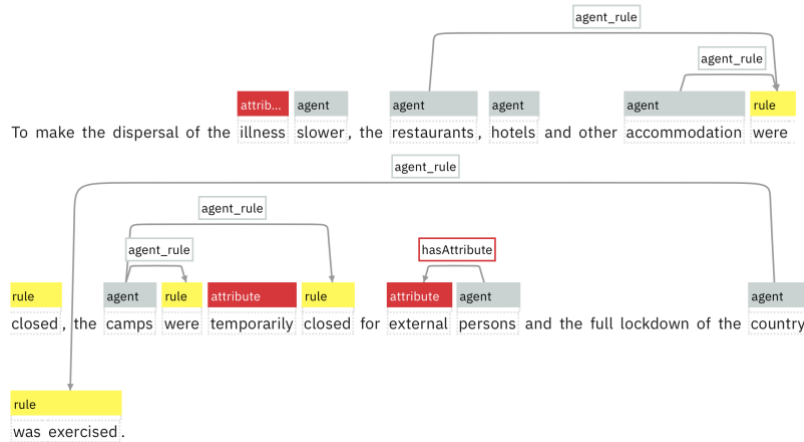

Figure 1: Example of agents, attributes, and rules from a refugee use case.

4   CONCLUSION

The results show that NLU models can provide a means of facilitating modeling to non-modelers by semi-automatically constructing model conceptualizations and specifications from descriptions of a phenomenon. NLU models enable the domain subject matter experts to be active participants in a stage of the computer modeling process where they currently do not have the specialized training and expertise.

REFERENCES

Padilla, J. J., D. Shuttleworth, and K. O'Brien. 2019. "Agent-Based Model Characterization using Natural Language Processing". In *Proceedings of the 2019 Winter Simulation Conference*, edited by N. Mustafee, K.-H.G. Bae, S. Lazarova-Molnar, M. Rabe, C. Szabo, P. Haas, and Y.-J. Son, pp. 560-571. Piscataway, New Jersey: Institute of Electrical and Electronics Engineers, Inc.