

Faculty of Engineering and Computing

Natural Language Processing

**NLP - Assignment**

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Please let me know if you would like any changes to the outline or if it's ready for me to proceed with writing the report.

# Proposed NLP Design Enhancements - The Goals

## 3.1 Goal 1 Anaphoric resolution: Description and design

The first goal is to improve the chatbot's ability to understand and resolve anaphora in user inputs. Anaphora resolution is a critical aspect of natural language understanding, as it helps determine the actual meaning of pronouns in a given context [1]. Implementing an efficient anaphora resolution system will enhance the chatbot's comprehension of user inputs and generate more accurate responses.

To achieve this goal, we propose to implement an anaphora resolution algorithm based on the state-of-the-art neural coreference resolution model, NeuralCoref(spacy) [2]. NeuralCoref is an unsupervised machine learning model that has been trained on a large corpus of text to identify coreferent clusters, which can be used to resolve anaphora in text [3]. By integrating NeuralCoref into our chatbot, we can effectively resolve pronouns in the user's input, leading to improved understanding and more coherent responses.

The design of our anaphora resolution module will involve the following steps:

1. Import the NeuralCoref library and load the pre-trained model.
2. Process the user's input with the NeuralCoref model to obtain coreference clusters.
3. Replace the pronouns in the user's input with their corresponding antecedents based on the coreference clusters.
4. Pass the updated input text to the GPT-2 model for generating a response.

To ensure the seamless integration of NeuralCoref into our chatbot, we will need to perform additional preprocessing on the user's input, such as tokenization and part-of-speech tagging. Furthermore, we will need to evaluate the performance of our anaphora resolution module to ensure it meets the desired level of accuracy.

### 3.1.1. Proposed NLP technique

To enhance our chatbot's anaphora resolution capabilities, we propose to implement a combination of rule-based and machine learning-based techniques. The integration of both techniques will allow the chatbot to resolve a wide range of anaphora scenarios, thus improving its overall understanding of user inputs and generating more accurate and coherent responses.

The first part of our proposed approach is a rule-based anaphora resolution technique. Rule-based anaphora resolution relies on a set of linguistic rules and heuristics to identify and resolve pronoun-antecedent relationships [4]. This approach is advantageous because it is relatively straightforward to implement, and it can achieve high precision in resolving anaphora when the rules are carefully designed [5]. However, rule-based techniques are generally limited in their ability to handle complex or ambiguous anaphora scenarios, which is why we propose to complement them with a machine learning-based technique.

In the rule-based part of our approach, we will implement a set of heuristic rules based on the syntactic and semantic properties of the text, such as the agreement in number, gender, and grammatical role between pronouns and their antecedents [6]. Additionally, we will use the distance between pronouns and potential antecedents, as well as the linear precedence of noun phrases, to further refine our anaphora resolution process [7]. To accomplish this, we will leverage the part-of-speech tagging and dependency parsing capabilities of the spaCy library [8].

The second part of our proposed approach is a machine learning-based anaphora resolution technique. Machine learning-based techniques have demonstrated significant success in resolving anaphora, as they can automatically learn complex patterns and relationships from large datasets [9]. In particular, neural network-based models have achieved state-of-the-art performance in coreference resolution tasks [10].

For our machine learning-based anaphora resolution technique, we will integrate the NeuralCoref model, which is built on top of the spaCy library and utilizes a deep neural network architecture to predict coreference links between pronouns and their antecedents [2]. NeuralCoref has been trained on a large corpus of text and can effectively identify coreferent clusters in a given text, making it an ideal choice for our chatbot's anaphora resolution module [3].

To combine the rule-based and machine learning-based techniques, we will first apply the heuristic rules to identify and resolve straightforward anaphora cases in the user's input. Then, we will use the NeuralCoref model to resolve any remaining pronouns that could not be handled by the rule-based approach. This combination of techniques will allow our chatbot to effectively resolve a wide range of anaphora scenarios, thus improving its overall understanding of user inputs and generating more accurate and coherent responses.

In order to evaluate the performance of our proposed NLP technique, we will use standard evaluation metrics such as precision, recall, and F1 score. We will also perform qualitative analysis by comparing the chatbot's generated responses before and after the integration of the anaphora resolution module. This evaluation process will help us fine-tune our approach and ensure that our chatbot's anaphora resolution capabilities meet the desired level of accuracy and effectiveness.

In summary, our proposed NLP technique combines rule-based and machine learning-based approaches to improve our chatbot's anaphora resolution capabilities. By implementing a set of heuristic rules and integrating the NeuralCoref model, we aim to enhance the chatbot's understanding of user inputs and generate more accurate and coherent responses.

# Research Goals

<This section describe project aim in simple statement and list project objectives following SMART description>

References

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[11] T. Wolf, P. Sanh, and S. Ruder, "NeuralCoref: Coreference resolution in spaCy with neural networks," GitHub Repository, 2019. [Online]. Available: https://github.com/huggingface/neuralcoref.