Comparison of CORD-19-trained GPT-2-based Chatbot Responses Across Different Text Semantic Similarity Approaches

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ABSTRACT

On March 16 (2020), per request of the White House Office of Science and Technology Policy, new COVID-19 machine readable dataset (CORD-19) [1] has been released. We have utilized 774M GPT-2 [2] model and applied transfer learning to retrain the model on this corpus. Ultimately, we have created a COVID-19 conversational chatbot. In order to improve the performance of the chatbot, we have applied 4 different text semantic similarity techniques using pretrained models including BERT [3], BioBERT [4], and Universal Sentence Encoder (USE) [5] as additional layers on top of GPT-2-based chatbot responses. We present the results annotated by experienced medical personnel at Mayo Clinic.

KEYWORDS

gpt-2, covid-19, cord-19, bert, biobert, universal sentence encoder, dataset, nlp, ai, semantic similarity

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1 INTRODUCTION

Chatbots have been much studied in recent years and with the advancements in the fields of artificial intelligence and natural language processing, both the the functionality and the performance have seen drastic improvements. Semantic similarity of texts, on the other hand, has been studied for a long time and recent breakthroughs allowed for development of new models such as BERT, BioBERT, and Universal Sentence Encoder. The paper takes an approach which is a marriage of these two and brings a different perspective on the chatbot creation. We first let a human ask a question and make GPT-2 come up with an answer. Then we further process the answer with additional filters and ultimately, apply a different model for finding the sentences that are most relevant to the question.

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2 CORPUS

We harvested the data from the initial *commercial use subset* of COVID-19 Open Research Dataset (CORD-19) [6] containing 9000 scholarly articles in the form of JSON files. We extracted the abstract and the main body of the article from every JSON file, combined them together, and used as a corpus for retraining the GPT-2 model.

3 TRANSFER LEARNING

We utilized GPT-2 774M model and ran transfer learning for 2500 iterations with the batch size of 8. We used Adam as the optimizer and set the learning rate of 0.0001. The model is available on our GitHub page.

4 SEMANTIC SIMILARITY

The GPT-2 responses are usually very lengthy and for the most part, the answer is not relevant to the question. To solve this problem, we chunked the answer into separate sentences and found the ones that are most *semantically similar* to the question asked. For this task, we have tested and applied 4 different approaches:

- BioBERT large v1.1 (+PubMed 1M) model based on BERT-large Cased (custom 30k vocabulary)
- Universal Sentence Encoder (USE), version 3, large
- Bert-Large, uncased (24 layers and 340M parameters)
- Scikit learn's Tfidfvectorizer

5 QUESTIONS AND EVALUATION

For evaluating the performance of the approaches, we chose 12 different questions. For each approach, we generated 5 different answers for the same question, resulting in the total of 240 answers. We then asked experienced medical personnel at Mayo Clinic to rate these answers. The questions are presented below.

- Are there geographic variations in the mortality rate of COVID-19?
- What is known about transmission, incubation, and environmental stability of COVID-19?
- Is there any evidence to suggest geographic based virus mutations of COVID-19?
- Are there geographic variations in the rate of COVID-19 spread?
- What do we know about virus genetics, origin, and evolution of COVID-19?
- What has been published about ethical and social science considerations of COVID-19?
- What has been published about medical care of COVID-19?
- What do we know about diagnostics and surveillance of COVID-19?

- What do we know about COVID-19 risk factors?
- What has been published about information sharing and inter-sectoral collaboration of COVID-19?
- What do we know about vaccines and therapeutics of COVID-19?
- What do we know about non-pharmaceutical interventions of COVID-19?

6 RESULTS

Approach	Score
TfidfVectorizer + Cosine Similarity	TBD
BERT + Cosine Similarity	TBD
BioBERT + Cosine Similarity	TBD
Universal Sentence Encoder (USE) + Inner Product	TBD

Figure 1: Comparison of 4 Different Approaches.

7 CONCLUSION

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