CSCE 5290: Natural Language processing
Project Increment -1

Project Title: Text Summarization of COVID-19 Articles using various NLP methods.

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Motivation:

Covid is a one of the kind new age viruses that shocked the world. We had very few resources that could tell us the sources, effects and handling this crisis. But our researchers were on it and started digging more about the treatment of this dangerous virus. As the researcher increases the covid related analysis published number also increases. But one cannot go through all these papers for his solution. Hence, we came up with the summarization model which summarizes the COVID-19 related articles which can answer the questions by summarizing the abstracts of the papers.

Objective:

To gather articles that include text summarization terms that focus on the medical domain of Covid-19 words.

Significance:

Not everybody has time to go through the complete research paper for their questions. Hence, this model would be a great tool for people who look for fast and effective solutions to their questions. Also, under developing or developing countries doesn't have the resources like hospitals and doctors. Hence, this would be a great tool to know effective answers for their questions without any misinformation.

Approach:

Unsupervised system for comprehending scientific literature that accepts questions in natural language with a focus keyword and retrieves precise responses from the CORD19 corpus of scientific papers.

Related Work

Extractive Summarization

Tan et al. [7] employed pre-trained BERT and GPT2 to synthesize Corona-related article summaries. Unsupervised extractive summarization and abstractive summarization make up the model's two components. A pre-trained BERT model is used for the first half, and the GPT-2 model for the second. The sentences are transformed into sentence embedding in the first stage using a pretrained BERT model. The set of sentence embeddings is then subjected to a k-medoid clustering to produce a set of cluster centers. An extractive summary is formed from the preceding sentences. Then, from the extractive summary, a number of keywords

are extracted using POS-tagger. The GPT2 model is given keyword-reference summary pairs, and upon training, system summaries are produced.

A recurrent neural network-based extractive summarization is suggested in this study. The extractive technique locates the text's informative passages. For evaluating sequences like text, recurrent neural networks are particularly effective. Sentence encoding, rating of sentences, and compilation of summaries are the three stages of the suggested methodology. An approach called coreference resolution is utilized to enhance the performance of the summarization system. Identifying mentions in the text that relate to the same thing outside the text is known as coreference resolution. Finding the main theme of the text through this technique aids in the summarizing process. [1]

Lakshmi Krishna et al. [11] compared pre-processing and model building for extractive summarization that were carried out for a small number of documents. BERT, Text rank, and GPT2 algorithms have been used to clean the text as much as possible. The performance of the GPT-2 algorithm produced the best results out of these models. This study is entirely reliant on pre-trained models; hence, training the model may result in a higher ROUGE score via better encoding representations of nodes.

Awane Widad et al. [15] presented a Question Answering tool based on BERT fine-tuned on the SQuAD benchmark. This tool takes CORD-19 dataset and uses 'Anserini', an open-source information search toolbox built around Lucene. This tool retrieves the relevant paragraph to the given question. Then this relevant set of paragraphs are sent to the BERT Text summarizer and then we use BERT pre-trained on SQuAD for answering of the questions.

Abdullah Javaid Chaudhry et al. [2] explored if "Termolator", a tool for extracting characteristic terms for a domain can be used to enhance the performance of extractive summarization approaches. They have used multiple approaches such as modified versions of TF-IDF vectors, BERT, modifications pf Word2Vec, K-Means clustering, Lex Rank, and template summarization. Evaluated the models with ROUGE family of metrics and concluded that the usage of characteristic terms for a domain as found by "Termolator" improves the performance of extractive summarization approaches with regards to the F-score. A model known as CAiRE-COVID has been presented by Su et al. [13].

The three major modules of CAiRE-COVID are information retrieval, question-and-answer, and summarization. After receiving a user query, the information retrieval module retrieves the top n most pertinent paragraphs. The most pertinent sentences found in the preceding stage are listed as the answer by the question-answering module. To choose the pertinent sentences from each of then paragraphs as the responses to the question, the question-answering module is applied to each of the n paragraphs. The top k paragraphs are then specified after these n paragraphs are once more reranked in accordance with the high-lighted replies. These k paragraphs are provided to the summarizer module, which then uses them to produce an extractive summary and an abstractive summary. The abstractive summary is produced using the UniLM and BART models, and the extractive one is produced using the cosine similarity of the sentences to the query.

Abstractive Summarization:

C Limploypipat et al. [8] In this article, they described how an LSTM neural network was used to abstractly summarize Covid-19 news. Also incorporate an attention mechanism into the encoder decoder neural network to help it focus on particular words and perform better. They produce training data sets with data augmentation and

testing data sets from COVID-19 CBC News stories for our experiments. The early findings of the studies demonstrate that summarization can produce shorter paragraphs that are succinct and simple for readers to understand.

In order to help overworked medical professionals locate reliable scientific information, Andre Esteva et al. [3] introduced a tool called CO-Search, a semantic, multi-stage search engine. CO-Search is intended to handle sophisticated searches across the COVID-19 literature. The two sequential components that make up CO-Search are a hybrid semantic-keyword retriever, which uses an input query to provide a sorted list of the 1,000 documents that are the most relevant, and a re-ranker, which further ranks the documents by relevance. Each document receives a relevance score from the re-ranker, which is determined by comparing the results of an abstractive summarization module with a question-answering module that measures how well each item responds to the query.

Shengli Song et al. [12] proposed an LSTM-CNN based ATS framework (ATSDL) that can construct new sentences by exploring more fine-grained fragments than sentences. ATSDL is composed of two main stages the first one which extracts phrases from source sentences and the second generates text summaries using deep learning. LSTM-CNN based ATS framework, named ATSDL. We apply LSTM model that was originally developed for machine translation to summarization and combine CNN and LSTM together to improve the performance of text summarization. After training, the new model will generate a sequence of phrases. This sequence is the text summary that is composed of natural sentences. (ii) In order to solve the key problem of rare words, we use phrase location information, so we can generate more natural sentences. (iii) The experiment results show that ATSDL outperforms state-of-the-art abstractive and extractive summarization systems on both two different datasets.

Deep Learning for Text Summarization:

Hayatin et al. [4] offered transformers as a core language model for producing abstractive summaries of COVID-19 news articles, utilizing architectural modification as the basis for developing the model, in research work related to the summarizing of COVID-19 news articles. They only used the MTDTG transformer model for abstractive text summarization in their research. The short summaries utilized for validation were insufficient to evaluate the summaries produced since they failed to capture the essence of the COVID-19 articles of the dataset.

Milad Moradi et al. [9] proposed an innovative method for summarizing that makes use of contextualized embeddings produced by the Bidirectional Encoder Representations from Transformers (BERT) model, a deep learning model that recently displayed cutting-edge outcomes in a number of natural language processing tasks. To find the most pertinent and instructive sentences within the input documents, they mix various BERT iterations with a clustering technique and compared the summarizer to a number of methods that have been previously reported in the literature using the ROUGE toolbox.

For extractive summarization, Rezaei et al. [10] used two deep learning architectures. Performing feature extraction and creating a feature-sentence matrix for the text sentences is the initial stage. Some of the most crucial sentence characteristics for text summarization are extracted at this stage, including sentence position, sentence length, TF-IDF, and title similarity. The Auto-Encoder neural network and the Deep Belief Network are the next two neural network types to receive this matrix as input. These networks augment the matrix. The sentence scores are calculated using this matrix, and the most significant and high-scoring sentences are chosen to be included in the summary.

A mechanism termed deepMINE has been proposed by Joshi et al [5]. The two primary components of this system are the Mine Article and the Article Summarization. The user enters the necessary keywords in the first section, and the system searches the article titles provided by CORD-19 to return related articles and links. The second component uses deep learning and natural language processing to summarize an input article.

Dataset:

In order to develop a treatment and preventative measures against the COVID-19 [14], the scientific literature needs to be surveyed by the global health and research community. The COVID-19 Open Research Dataset (CORD-19) was created by the White House and top research organizations in response to this challenge in order to bring in the NLP expertise to help uncover the solution within the literature or provide insights to the general public. Over 59,000 research articles, including over 47,000 full-text articles about the COVID-19 or associated disorders, are included in this dataset. The dataset contains research papers from way before 2020. Hence, we segmented the dataset and dropped the research papers that are before 2020.

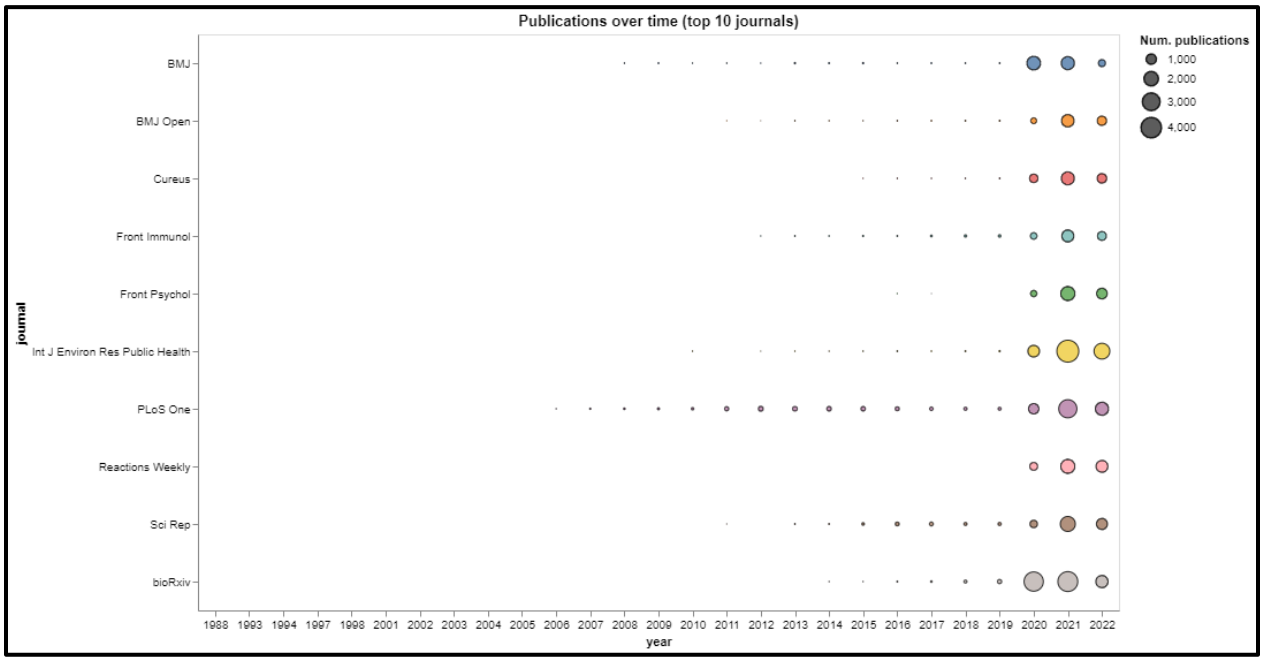

Fig 1: Distribution of Papers

In the above figure, it showcases the distribution of the research papers over the years. Then we segmented the dataset in such a way that we only retained the research papers from year 2020 and dropped the remaining.

Detail design of Features:

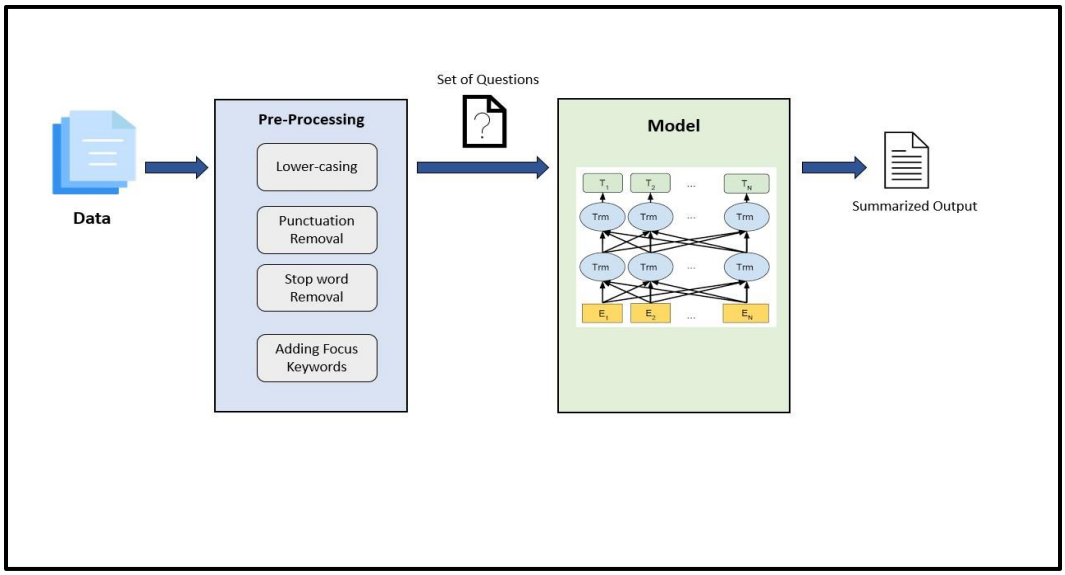

Fig 2: Data Pre-processing/Tokenization Methods

Data preprocessing is a vital step in building a Machine Learning/Deep Learning model. The quality of the preprocessing determines the model's performance [6]. There are various techniques that can be employed to clean the raw text we have. We chose to build a Text pre-processing pipeline in which we firstly lower-case the corpus we have at hand for uniformity and eliminating the punctuation marks and then we get rid of the most frequent stop words that do not add great significance to the context of the text. Stemming and Lemmatization are few very well-known text pre-processing methods, but in- stead of doing it manually. We employed the BERT models to the Stemming and Lemmatization. After these basic text pre-processing techniques. We have added Focus Keywords which can focuses specifically on few things related to the COVID and its symptoms. We included these specific keywords because the dataset is huge and has many research papers. To keep our focus on few topics would make our search and summaries precise. As part of cleaning the data, we dropped Null value columns, duplicate titles and consider research papers from the year 2020. We create a data frame in which we try to hold the abstracts of the papers which contains terms related to the COVID and its symptoms. Created a Data Frame such that, the data frame contains the abstracts of the paper which focuses on the given focus words. Later we used sentence similarity from the SpaCy library to calculate the similarity of the given sentence to that of the summarized answer.

Analysis

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(463005, 7)
(275107, 7)
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	sha	title	doi	abstract	publish_time	authors	journal
10	2ecd2df3b19e54d13d8877422fca3328f0fc5256	COVID-19 Vaccine Priority for People With Neur...	10.14740/jnr665	no data providedcovid-19 vaccine priority for ...	45402	Pfeffer, Gerald; Jacob, Sarah; Preston, Jeffrey	J Neurol Res
13	746889ad718cbc5154785a86863262e1d31c71c1	A 'Multiomic' Approach of Saliva Metabolomics,...	10.1016/j.gastha.2021.12.006	background and aims the sars-cov-2 pandemic ha...	44926	Pozzi, Chiara; Levi, Riccardo; Braga, Daniele;...	Gastro Hep Advances
14	c42b3698a5925cca3f5d59df41aaaeabe84627c2	Chapter 8 Infectious Disease Emergencies	10.1016/b978-0-323-83375-2.00008-5	covid-19 has added new relevance to the relati...	44926	Aliyeva, Gulnara Davud	Rapid Response Situations
15	d64935bc0335df545954b34b3bbff8ca249dfd73	Two viruses, one prescription: slow down	10.1016/j.trpro.2021.12.034	the covid-19 pandemic has devastated communiti...	44926	Tolley, Rodney; Tranter, Paul	Transportation Research Procedia
16	0268b9f3837b8e568b3ec59c69b285b41d725d69	A Workspace Typology for Enterprise Collaborat...	10.1016/j.procs.2021.12.017	the global covid-19 pandemic and the need for ...	44926	Bahles, Sebastian; Schwade, Florian; Schubert,...	Procedia Computer Science

Fig 3: Sample of dataset

The above figure showcases the snapshot of the dataset. The dimensions of the original dataset are (463005,7). The dataset is so huge for the BERT model to run on the local machine and as we do not have GPU machine, we segmented the dataset to run the model comfortably and after dropping the articles the new segmented dataset is of size 275107

Implementation & Results

Text summarization using BERT

BERT is a free and open-source machine learning framework for natural language processing. BERT uses the surrounding text to provide context in order to help machines understand the meaning of ambiguous words in text. The BERT framework was pre-trained using text from Wikipedia and can be fine-tuned with question-and-answer datasets.

Transformer, an attention mechanism that recognizes contextual relationships between words in a text, is used by BERT. Transformer's basic design consists of two independent mechanisms: an encoder that reads the text input and a decoder that generates job predictions. Only the encoder mechanism is required because BERT's aim is to produce a language model.

After all the pre-processing steps, we created a set of questions that was fed to model. The model takes in the set of questions and tries to search for the relevant research papers from the dataset using the keywords. It retrieves the abstract of the related research papers and then tries to summarize all these abstracts and make a summarized answer.

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# QUESTIONS

search=[
'What is the effectiveness of drugs being developed and tried to treat COVID-19 patients?',
'Clinical and bench trials to investigate less common viral inhibitors against COVID-19 such as naproxen clarithromycin, and minocyclinethat that may
'How are potential complications of Antibody-Dependent Enhancement ADE in vaccine recipients being researched?',
'Exploration of use of best animal models and their predictive value for a human vaccine',
'Capabilities to discover a therapeutic not vaccine for the disease, and clinical effectiveness studies to discover therapeutics, to include antivira
'Alternative models to aid decision makers in determining how to prioritize and distribute scarce, newly proven therapeutics as production ramps up a
'What research and work is being done to develop a universal vaccine for coronavirus',
'What work and research has been done to develop animal models and standardize challenge studies',
'What work and research has been done to develop prophylaxis clinical studies and prioritize in healthcare workers',
'Approaches to evaluate risk for enhanced disease after vaccination',
'Assays to evaluate vaccine immune response and process development for vaccines, alongside suitable animal models in conjunction with therapeutics'
]

# MAIN FOCUS KEYWORDS

focus=['drugs','drugs','antibodies','animal model','therapeutic','models','vaccine','model','drugs','vaccine','animal']
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Fig 4: Set of questions and Keywords

In the above figure, we created a set of questions. Based on these questions and the keywords the BERT model searches the articles with the best matching abstracts using the cosine similarity score.

What is the effectiveness of drugs being developed and tried to treat COVID-19 patients?

Summarized Answer:

This study aimed to compare clinical outcomes between mild covid-19 patients receiving antiviral drugs and those without. Health-care systems are using repurposing drugs to cure the patients from this infection. Using drugs to treat covid-19 symptoms may induce adverse effects and modify patient outcomes.

results limited to 5 for ease of scanning

	pub_date	title	excerpt	rel_score
44408		Antiviral treatment could not provide clinical benefit in management of mild COVID-19: A Retrospective Experience from Field hospital	This study aimed to compare clinical outcomes between mild covid-19 patients receiving antiviral drugs and those without. Conclusion: antiviral treatment could not provide superior clinical outcomes to supportive care in mild covid-19 patients.	0.847536
44042		Designing therapeutic strategies to combat severe acute respiratory syndrome coronavirus-2 disease: COVID-19.	Drug candidates currently under consideration and undergoing clinical trials for covid-19 treatment are highlighted.designing therapeutic strategies to combat severe acute respiratory syndrome coronavirus-2 disease: covid-19.	0.845013
44563		In silico study of remdesivir with and without ionic liquids having different cations using DFT calculations and molecular docking	Health-care systems are using repurposing drugs to cure the patients from this infection.	0.840591
44511		P025 Risk assessment of covid 19 in patients with Juvenile Idiopathic Arthritis	Patients with inflammatory rheumatic diseases undergoing immunosuppressive treatment are considered immunocompromised.	0.840143
44228		Effectiveness of early therapeutic intervention in phases one and two after COVID-19 infection: systematic review.	Conclusion studies have reported that effective drugs for treating covid-19 exist.	0.839931

Clinical and bench trials to investigate less common viral inhibitors against COVID-19 such as naproxen clarithromycin, and minocyclinethat that may exert effects on viral replication

Summarized Answer:

Several antibody drugs have successfully entered clinical trials and achieved impressive therapeutic effects. The antiviral drugs affecting viral replication and those modulating the immune response, reduce the infected cells and viral load significantly.

results limited to 5 for ease of scanning

Fig 5: Output of given Questions

We set to retrieve only the top 5 titles with the highest relevancy score and from the above figure we can see that we get the highest relevancy score of 84.75%. And also, we can see our set of keywords in the abstract so we can clearly say that our model is also working based on the keywords. As part of our evaluation metrics, we included Cosine Similarity. The questions set compares with the each abstract of the articles and get the similarities score.

Implementation Status Report

Work Completed

We have created a Question answering and Text summarizing using the BERT model.

- Harsha – Related Work, Analysis
- Roshan – Dataset, Detail Design of features

We both worked equally on Implementation and Results.

Work to be Completed

We are planning to compare this BERT model to a DistilBERT model and also try to look for different evaluation metrics.

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GitHub Link - https://github.com/ErRsah/NLP