

NLP with Deep Learning Approaches in Text Generation

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Abstract – Text generation is the process of automatically producing coherent and meaningful text, which can be in the form of sentences, paragraphs or even entire documents. It involves various techniques, which can be found under the field such as Natural Language Processing (NLP) and deep learning algorithms, to analyze input data and generate human-like text. The goal is to create text that is not only grammatically correct but also contextually appropriate and engaging for the intended audience. In advance we want to focus on text summarization because for generating text includes correct formation of sentence and reduce the user difficulty. Here we use deep learning techniques like Recurrent neural network (RNN), Generative pre-trained transformer (GPT), Bi-directional encoder representations from transformers (BERT). Text summarization models often face challenges such as lack of precision, vocabulary limitations, incorrect sentences, and false information.

Keywords: RNN, CNN, Text Generation, NLP, BERT

I. INTRODUCTION

Humans think unique when compare to machine because every human has different thinking power and unique thoughts and every human have ability to communicate with each other and share knowledge with others. by using the Natural Language processing (NLP) machine can summarize the text and produce Text like a human. Today's digital world vast number of text data is created every day especially on social media like tweets, messages, and lot of content is provided. Most of this data is unstructured data it is difficult to understand by others Natural language is a field of artificial intelligence that enables computer to process and understand, and interpret human language and produce like a human text efficiently. For text summarization and generation for analyze the text deep learning models are used these deep learning models learn language patterns and meaning, helping to create accurate and coherent text. by using natural language processing is computers understand and generate human like text more accurately. Traditional NLP methods relied on rules and simple machine learning, but by using NLP with deep learning Become more powerful and produce human like text

deep learning use the artificial intelligent for mimic the human brain to analyze the large data and process the large amount of text data. Deep learning used to learn patterns, context, meaning for the large datasets making capable of tasks like text generation, summarization, translation, and sentiment analysis. These deep learning model understand not only individual words but also their relationships in the sentence allowing the methods to produce human like responses. Deep learning in NLP has applications like Chabot, search engines, and voice assistants, making interactions with technology more natural and efficient

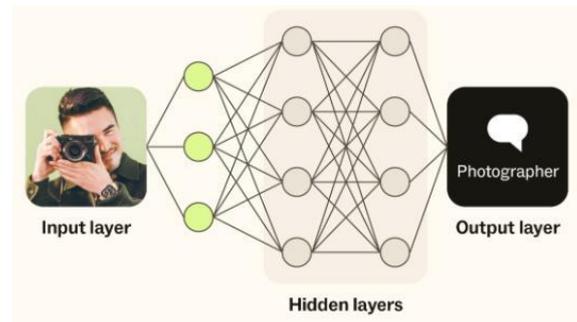


Figure 1: Deep Learning Process

It begins with feeding the computer a variety of information, such as images, text, or numbers, so it can identify patterns. This learning process happens through a structure called a neural network, which adjusts itself over time to improve accuracy. After training, the model is tested to see how well it performs, and if errors occur, it is refined to enhance its performance. Once properly trained, the system can make intelligent predictions, such as recognizing faces, translating languages, or detecting objects in images. Essentially, it mimics human learning by practicing with examples until it becomes highly accurate.

II. TEXT SUMMARIZATION

It refers to process of automatically generating a concise it means shorter and meaningful summary of a longer text using neural networks, either by extracting a key sentences or generating new sentences. The main purpose of text summarization is to firstly extract relevant or essential matter

from large documents, it makes content more accessible, time saving and easy to understand. It will automates the process of reducing long texts into shorter versions and meaningful summaries manner. Summarization helps users can easily extract essential information from large volumes of data. It will reduces the length of long texts it preserves essential information. It improves readability and easy understanding of complex documents. It will automatically content will be processing in news, research and business. It includes various applications such as news, document analysis and chatbot. By using deep learning models that generate high quality summaries. The models such as transformers like BERT, T5 and GPT it can analyze text contextually and it will produce human like summaries.

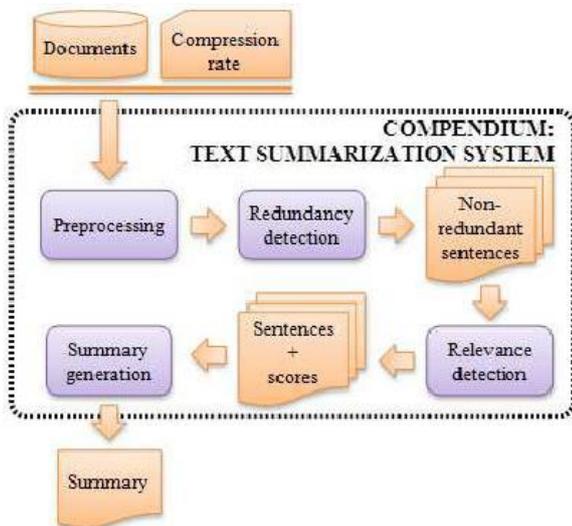


Figure 2: Text Summarization Process

Types of Text Summarization

1. Extractive Text Summarization
2. Abstractive Text Summarization

2.1 Extractive Text Summarization

In today's world, large amount of information are generated daily it makes difficult of reading and process everything. It is a method of shortens a text by selecting key sentences directly from original content. It will picks the most important sentences or phrases from a text without changing original text. It works, it will finds key sentences and keep the original text it means it does not rewrite just it will extracts and also it will maintaining meaning. Unlike abstractive summarization it will rewrites text in new sentences but extractive summarization keeps original sentences. This method is used in news articles, documents to quickly highlighting key points. By analyzing sentence based on keywords, frequency and structure. It will helps users or

readers quickly grasp essential information efficiently. It helps in reducing reading time also while maintaining original meaning of the text. It becomes essential for efficient reading and knowledge extraction. It is a powerful tool helps in managing large amounts of text by quickly identifying and presenting most relevant information. The techniques used is the Recurrent Neural Networks (RNN) like Long Short Term Memory (LSTM) and Gated Recurrent Unit (GRU).

In RNN like LSTM which is a type of Recurrent Network, the main goal is to analyze and extracting most important sentences from a document while preserves original content. It captures long range dependencies it will remember relevant information from earlier sentences for long time helping in understanding the context better. It will handles sequential data, it also process one word or sentence at a time it will process and select better sentences. LSTM's use memory cells and gates it will hold important information and filters the less relevant information. It will improves coherence by understanding sentence importance based on context, it will extracts summary .LSTM models identify sentences which is having most important meaning of the document. It will handles large texts effectively and reduces redundancy by using scoring functions it will extracted sentences are relevant without unnecessary repetition. It can be trained large datasets for different types of content. It avoids and prevents irrelevant sentences that are less useful or repetitive. Attention layers also will be added to LSTM models to focus on key sentences improving summarization quality. In Gated Recurrent Unit (GRU) it works similarly to LSTM but is faster and requires fewer resources. It helps in understands relationships between words, that summary consists main content while removing unnecessary information. GRU also remembers important parts of text, helping to choose meaningful sentences for summary. It processes long documents while keep key points. Easier to train it is effective. It keeps summary clear since it extracts sentences, the summary is natural and easy to read. It reduces unnecessary information and it is efficient for summarizing big documents and can work well.

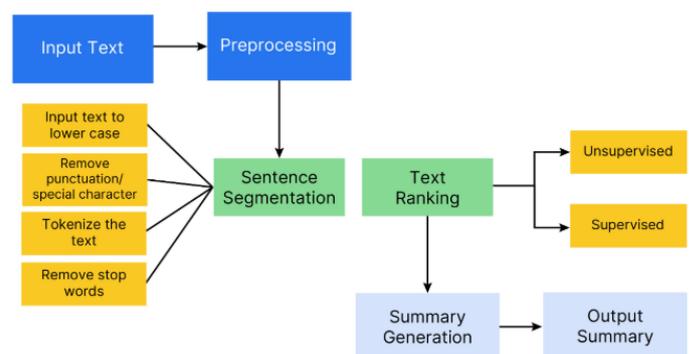


Figure 3: Extractive Text summarization

2.2 Abstractive Text Summarization

It is technique it generates a summary in own words. It understands the meaning of input text and then rewrites a shorter versions while preserves original content. The model reads and analyzes input text and it will extracts key information and generates a concise summary using new words. It creates summaries human like and clear. It handles large amount of information by using shorter and it removes redundancy data. The sentences are rewritten rather than original text and more flexible. The techniques used in abstractive summarization such as Bidirectional Encoder Representations from Transformers (BERT), Generative pertained Transformers (GPT).In BERT it will mainly understand the full context of words in sentence and process text bidirectional like left to right and right to left simultaneously. It will helps to generate concise and meaningful summaries by understanding overall meaning of input text. It captures the full meaning of words and generates better summary generation and Rephrases the sentences into a shorter and fluent summary. It improves summary coherence. It produce summaries it captures the true text, the summaries like human like text. It is more effective, as it considers full sentence relationships. It produces high quality summaries and it allows summarization in different languages, works well for multiple languages. It helps to focus on most important parts of text, leading to better and more relevant summaries. In Generative pertained Transformers (GPT) is a decoder model for text generation. It is trained on massive datasets to understand and generate human like text, it rewrites the main content of text in own words producing natural and coherent summary. Instead of copying sentences, it reconstructs the main content in new sentences. It will make the summary more and avoids redundancy. GPT analyzes the entire text and identify important points. It uses attention mechanisms to focus on relevant content. Works well for various content types and domains. Understand and rewrite text with high accuracy the model ensures grammatical correctness before generating final output.

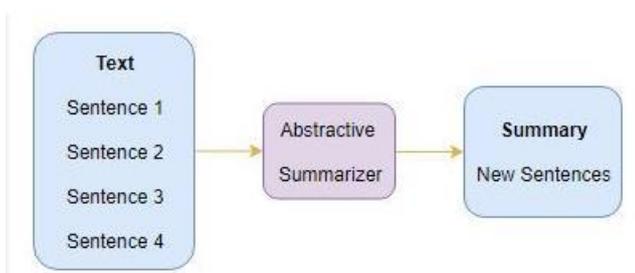


Figure 4: Abstractive Text Summarization

Advantages

1. It will not just pick important sentences but also understand full context of meaning.
2. It will generate summaries accurately capture the key message without losing essential information.
3. Summarized content is coherent and grammatically correct.
4. Handles long document without missing crucial information while removing unnecessary content, it makes information easy to understand.
5. It will saves time and reduces human effort.
6. Helps users quickly extract relevant information from long documents.

III. TEXT GENERATION

Text generation is a crucial task of natural language processing (NLP) that involves automatically producing meaningful and coherent text from input data.it aims to generate human-like text based on context, making it widely applicable in areas like The objective of text generation is to generate coherent, contextually relevant, and meaningful text that resembles human language. Over time, text generation has evolved from simple rule-based approaches to advanced deep learning models.

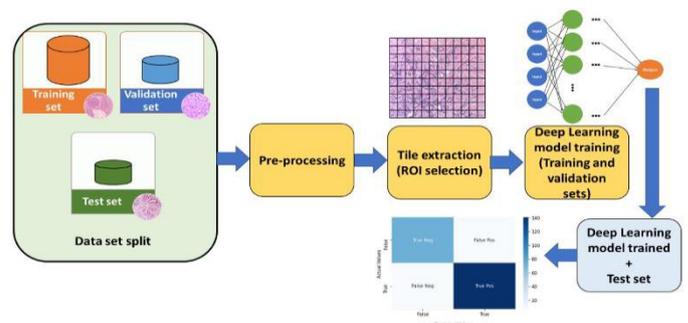


Figure 5: Text Generation Process

3.1 Approaches to Text Generation In NLP

Rule based Text Generation: The earliest form of text generation was rule-based, relying on predefined rules, and structured grammar.

3.1.1 Statistical Language Models (SLM): Statistical Language Models generate text by estimating the probability of a word appearing in a sentence based on previous words. These models are trained on large corpora of text data.

N-gram Model:

The most common statistical model is the N-gram model, where:

- Bigram (N=2): Predicts the next word using the previous one.
- Trigram (N=3): Predicts the next word using the previous two words.

3.1.2 Neural Network-Based Text Generation: Neural networks revolutionized text generation by learning complex patterns and generating human like text. The most common models are:

a) Recurrent Neural Networks (RNN): RNNs process sequential data and generate text word-by-word based on previous inputs.

Working Principle:

- Takes input text – Predicts the next word – Updates hidden state – Repeats.

b) Long Short-Term Memory (LSTM): LSTM is an advanced form of RNN that vanishing gradient problem. It uses memory cells and gates retain long-term dependencies.

Advantages:

- Handles long-range context better.
- Generates more meaningful and contextual text.

Popular Transformer Models:

1. GPT (Generative Pre-trained Transformer): Generates human-like text from prompts.
2. BERT (Bidirectional Encoder Representations from Transformers): Understands text but not designed for generation.

Working Principle:

- Trained on billions of text samples from books, web pages, and documents.
- Given a prompt, it generates contextually relevant text.

3.1.3 Text Generation Techniques:

Here are some common techniques used for text generation

1. Greedy Search: Always picks the word with the highest probability.
2. Beam Search: keeps multiple possibilities at each step and chooses the best.
3. Top-k Sampling: Limits vocabulary to the top k probable words.
4. Nucleus Sampling: Dynamically adjusts vocabulary size based on probability mass.

Applications of Text Generation:

1. Chat bots
2. Story writing
3. Code generation
4. Dialogue systems

IV. CONCLUSION

Basically, deep learning has made computers way better at writing. Think of it like teaching a robot to read a ton of books, so it can then write its own stories. We've gone from simple fill-in-the-blank stuff to robots that can write poems and have conversations. We're using fancy tools like "Transformers" that help computers understand the meaning behind words. It's really cool, but it's not perfect. Sometimes the robot might write something that's not true, or it might accidentally write something that's unfair or biased. Scientists are working hard to fix these problems and make the robots even better. The goal is to make computers that can write so well that we can use them to create all sorts of things, like better chat bots, helpful writing tools, and even new forms of art. It's like we're just starting to see what's possible, and to change how we use words forever.

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