

Title	Abstractive Text Summarization Using Deep Learning
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Abstract

Text summarization is one of the most active research in natural language processing. Even though the history of text summarization dates back to 1950s, a majority of research focuses on extractive summarization in which we select some sentences from the input document as the summary. Abstractive summarization is considered as closer to human style, but it has not got enough attention from the community over the years due to its difficulty and complexity.

With the development of deep learning lately, we have witnessed many impressive results in various fields ranging from computer vision to natural language processing. Using deep learning for abstractive summarization has also yielded promising results in recently published papers. However, it is still in an early stage, and more research needs to be done in this field. This thesis presents our study on abstractive text summarization and our contributions: (1) we implement two deep learning models for summarization with different encoding mechanism, then we compare their performance in terms of ROUGE score and computational time; (2) we improve the quality of the summary by employing diverse beam-search decoding and we propose a method to deal with the problem of word redundancy in the output.

First of all, we introduce a widely used deep learning model for abstractive summarization, the encoder-decoder model using recurrent neural network (RNN). In this model, the document is simply viewed as a sequence of words. Based on that, we implement a second model for comparison which treats the input document as a hierarchical structure. To be specific, we use Convolutional Neural Network (CNN) to get the representation of each sentence and use Bidirectional RNN to encode these sentence vectors. By doing this, we hope to reduce the computational complexity of the whole network while still achieving a competitive performance comparing to the standard model. Our experiments show that the hierarchical encoding model achieves comparable full-length ROUGE-1 and ROUGE-L scores while having the smallest computational time. But its ROUGE-2 score is much lower than the standard model. Because ROUGE-2 is an important metric for evaluation, it partly indicates the weakness of hierarchical model in generating a good summary. Our additional experiments also demonstrate the effectiveness of using Part-of-Speech feature for improving the system performance as well as the minor effect of removing stop words from the input document.

Our second work presented in this thesis focuses on the decoding process of neural summarization. The summaries in our deep learning model are generated by using beam-search, a frequently used method in neural text summarization model. By using beam-search with beam size K , we can generate K -best list of outputs and the output with the highest score assigned by the model is selected as the summary. However, this score might not reflect the quality of the summary, i.e. a summary with a lower score can be a better summary. This can be fixed by using a re-ranking stage. The main issue with beam-search is that it produces K -best list with very similar lexical content, which consequently reduces the effectiveness of re-ranking model. To deal with this issue, we

chose to adopt a technique proposed recently to help generating diverse outputs. This method controls the dissimilarity between beams at each step by assigning lower priority to tokens which were already chosen in other beams. The combination with an re-ranker shows the effectiveness of this technique since it yields higher Full-length F1 ROUGE score than the default decoding method.

Another issue found in our summarization model is the repetition of words and phrases, a common problem which has been recognized in other similar works. In this research, we proposed a simple solution which can be incorporated easily into the decoding process. More specifically, we guide the word expansion process in beam search algorithm by assigning lower score to words which can cause the repetition issue. For this purpose, we designed a function to tell how much a word is likely to be repeated based on the unigrams and bigrams of previously decoded tokens in that beam. After performing the evaluation, we found that our proposed method can increase the baseline ROUGE score by up to 40% or more when combining with an Oracle re-ranker. Thus, this method can give researchers another way to improve their existing model without modifying the training architecture.

Despite there are several limitations, our work at least provides more aid for other future research in this field. Our findings and results not only can be applied to abstractive text summarization problem but also for other similar research such as image caption generation, machine translation or spoken dialog generation.

Keywords: abstractive text summarization, deep learning, natural language processing, diverse beam search, re-ranking.