Practice #4

DeepSC

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1 Introduction

According to Shannon and Weaver, communication can be classified into three tiers:

1. the transmission of symbols;
2. the exchange of semantic meaning conveyed by these symbols;
3. the impact of exchanging semantic information.

The initial tier of communication is primarily concerned with the successful transmission of symbols from the sender to the receiver, where the accuracy of transmission is typically evaluated at the level of bits or symbols. The second tier of communication addresses the semantic content conveyed by the sender and the interpretation of meaning by the receiver, referred to as semantic communication. The third tier involves the repercussions of communication, leading to the receiver's ability to carry out specific tasks in line with the intentions of the sender.

The homework is devoted to reproducing the results of the paper "Deep Learning Enabled Semantic Communication Systems". The authors incorporated insights from the Transformer ("Attention is all you need", A. Vaswani, et al.), a groundbreaking framework for DeepSC has been introduced, demonstrating a capability to efficiently extract semantic information from texts while maintaining resilience against noise. This novel DeepSC framework incorporates a joint semantic-channel coding methodology, tailored to address the challenges posed by channel noise and semantic distortion. The transceiver architecture of DeepSC comprises semantic encoder, channel encoder, channel decoder, and semantic decoder components. The design emphasizes both understanding semantic meaning and maximizing system capacity by optimizing the receiver with two loss functions: cross-entropy and mutual information. Additionally, a new metric has been devised to accurately gauge DeepSC performance at the semantic level. To extend the applicability of DeepSC across diverse communication scenarios, deep transfer learning techniques have been incorporated to expedite model re-training. This approach enables the re-trained DeepSC model to recognize various knowledge inputs and recover semantic information from distortion.

2 Task

The task of the following work is to reproduce the results of the paper "Deep Learning Enabled Semantic Communication Systems". The objective is to gain practical experience in implementing and evaluating deep learning techniques for semantic communication systems as described in the paper.

Instructions:

1. Read the paper "Deep Learning Enabled Semantic Communication Systems" to understand the proposed approach, methodology, and experimental setup.
2. Select one specific aspect or model from the paper that you would like to focus on for the reproduction of results.
3. Take the model provided by https://github.com/13274086/DeepSC/tree/master.
4. Train the model using the provided dataset or a relevant dataset from a similar domain.
5. Evaluate the performance of the model by comparing the results with those reported in the paper.
6. Document the entire process, including the code, experimental setup, and results in a report.
7. Discuss any challenges encountered during the reproduction process and potential improvements for future work.

Deliverables:

- Code implementation of the selected model or approach (a link to a github repository with the code modified for your purposes).
- Experimental results and performance evaluation
- A report summarizing the reproduction process, including a discussion of challenges and potential improvements.

Upon completion of the homework generated above, you will gain several valuable skills and knowledge, including the understanding the application of deep learning techniques in semantic communication systems, along with the ability to implement and evaluate these techniques in practice; gaining experience in replicating and reproducing results from an existing research paper, demonstrating the ability to understand, implement, and critically analyze the methods and findings presented in academic literature; encouraging critical thinking and problem-solving skills by addressing challenges encountered during the reproduction process and proposing potential improvements for future work.

Helpful tutorials

- https://arxiv.org/abs/2006.10685
- https://github.com/13274086/DeepSC/tree/master