Neural Network Based Decoding over Molecular Communication Channels

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Abstract

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0.1 Introduction

Characterizing and obtaining information about communication channels is a fundamental barrier to communication. While optimal and sub-optimal strategies for overcoming this barrier in many contexts have enabled vast and effective communication infrastructure, this barrier still limits communication in others. Molecular Communication channels pose a particularly difficult context in which to overcome this barrier as channel characteristics are often non-linear and may be dependent on the specific transmitted information stream. In communication contexts, such as wireless, long, "Pilot" symbol-streams are often used to mitigate the difficultly in obtaining channel information by provide real-time information supporting an underlying channel model. The low symbol rate of Molecular Communication channels often makes such strategies impractical. However, the success of this data-driven technique in wireless channels suggest that perhaps an alternative, data-driven method may be viable in the Molecular Communication context. One potential data-driven method for characterizing these channels is a neural network. Neural networks have shown to be an effective tool in data-driven approximating of probability distributions.

The general communication channel is equivalent to a conditional probability $P(x|y)$, in which x is transmitted information and y is received information. $P(x|y)$ takes into account the (potentially random) channel through which the information x passes, and random noise added prior to receiving y. The communication problem entails optimizing a form of $P(x|y)$ over a set of possible, transmitted information. In general, sub-optimal solutions do not require perfect knowledge of the distribution $P(x|y)$ and may be used when $P(x|y)$ is unknown or impractical to obtain. In this work, a neural network is used to estimate $P(x|y)$.

0.2 System Model

0.2.1 MLSE

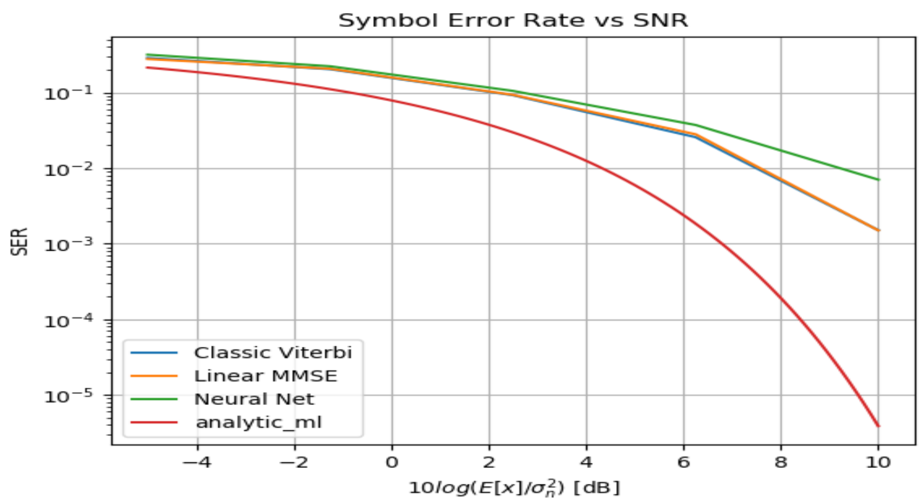
0.3 Numerical Results

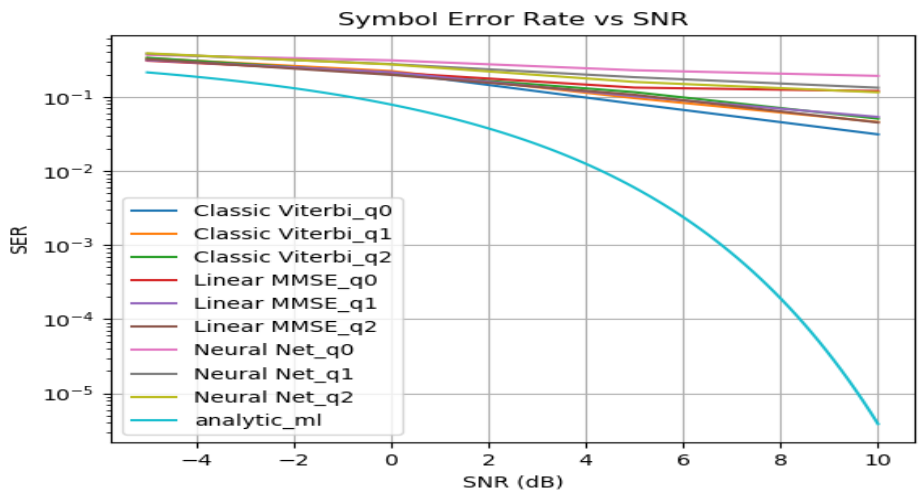
Proposed Figures

- ViterbiNet Performance compared to MMSE and classic Viterbi LTI Channel

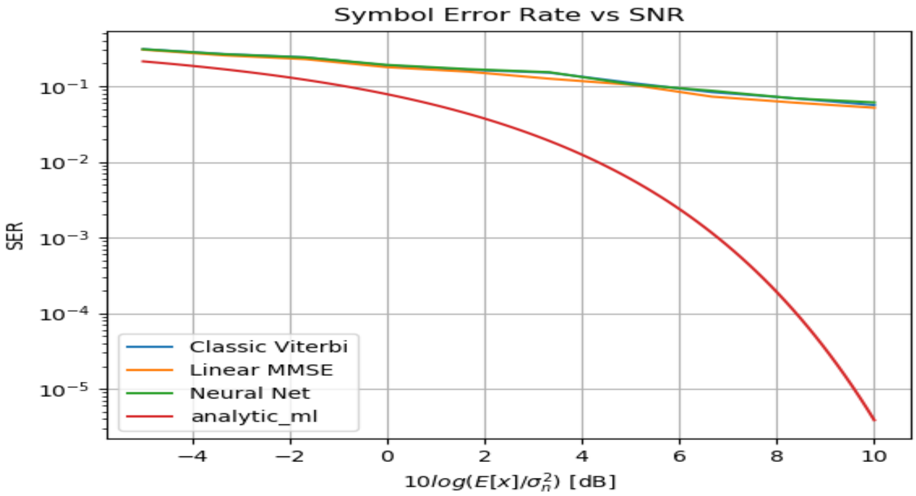
- ViterbiNet Performance compared to MMSE and classic Viterbi non-linear Channel
- Reduced ViterbiNet on LTI Channel
- Reduced ViterbiNet on non-linear Channel

ViterbiNet





Reduced State ViterbiNet



0.4 Conclusion