Machine Learning Autoencoder Applied to Communication Channels

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Outline

- Introduction
- 2 Methodology
 - Reference Model
 - Design & Architecture
 - Training
 - Predictions
- Results & Discussions
 - DNN Decoders
 - DNN Autoencoders
- 4 Conclusions
- 5 Future Work



Context

Communication system context in general - what field will I be treating

- My first point.
- My second point.



Context

Machine Learning applications - what could we do in communication system

- My first point.
- My second point.



Relevance & Challenges

Explain why the work is relevant and explain what are the challenges

- My first point.
- My second point.



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Problem Statement

What exactly I will solve in this work

- My first point.
- My second point.



• First item.



- First item.
- Second item.



- First item.
- Second item.
- Third item.



- First item.
- Second item.
- Third item.
- Fourth item.



- First item.
- Second item.
- Third item.
- Fourth item.
- Fifth item.



- First item.
- Second item.
- Third item.
- Fourth item.
- Fifth item. Extra text in the fifth item.



Maximum a Posterior (MAP) Rule

Implementation of a MAP decoder for a linear block code through a BSC.

- My first point.
- My second point.



Neural Network's Architecture

Show the architecture used for each case and remarks some important parameters

- My first point.
- My second point.



Neural Network's Training

Show the best training parameters for each structure

- My first point.
- My second point.



Monte Carlo Simulations

Explain how we could use NN to predict the results with certain confidence.

- My first point.
- My second point.



Blocks

Block Title

You can also highlight sections of your presentation in a block, with it's own title

Theorem

There are separate environments for theorems, examples, definitions and proofs.

Example

Here is an example of an example block.



DNN Array Decoder

Show the results for the array decoder in terms of train p, Mep, Parameters, etc

- My first point.
- My second point.



DNN One-hot Decoder

Show the results for the one-hot decoder in terms of train p, Mep, Parameters, etc

- My first point.
- My second point.



DNN Autoencoder

Show the results for the autoencoder in terms of train p, Mep, Parameters, etc

- My first point.
- My second point.



Conclusions

- My first point.
- My second point.



Future Work

- My first point.
- My second point.



Acknowledgment

- My first point.
- My second point.



Bibliography I

- [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15]
- C. E. Shannon, "A mathematical theory of communication," *SIGMOBILE Mob. Comput. Commun. Rev.*, vol. 5, pp. 3–55, Jan. 2001.
- F. D. Calabrese, L. Wang, E. Ghadimi, G. Peters, and P. Soldati, "Learning radio resource management in 5g networks: Framework, opportunities and challenges," *CoRR*, vol. abs/1611.10253, 2016.
- T. J. O'Shea and J. Hoydis, "An introduction to machine learning communications systems," *CoRR*, vol. abs/1702.00832, 2017.
- T. J. O'Shea, K. Karra, and T. C. Clancy, "Learning to Communicate: Channel Auto-encoders, Domain Specific Regularizers, and Attention," arXiv e-prints, Aug. 2016.



Bibliography II

- D. Goldin and D. Burshtein, "Performance Bounds of Concatenated Polar Coding Schemes," arXiv e-prints, Oct. 2017.
- E. Worm, S. Member, P. Hoeher, S. Member, and N. Wehn, "Turbo-decoding without snr estimation," *IEEE Communications Letters*, pp. 193–195, 2000.
- A. J. Viterbi, "Error bounds for convolutional codes and an asymptotically optimum decoding algorithm," *IEEE Transactions on Information Theory*, vol. IT-13, pp. 260–269, April 1967.
- P. Robertson, P. A. Hoeher, and E. Villebrun, "Optimal and sub-optimal maximum a posteriori algorithms suitable for turbo decoding.," *European Transactions on Telecommunications*, vol. 8, no. 2, pp. 119–125, 1997.

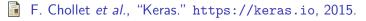


Bibliography III

- M. Ibnkahla, "Applications of neural networks to digital communications-survey," *Signal Processing*, vol. 80, pp. 1185–1215, 07 2000.
- M. A. Nielsen, "Neural networks and deep learning," 2018.
- K. P. Murphy, *Machine learning: a probabilistic perspective*. Cambridge, Mass. [u.a.]: MIT Press, 2013.
- M. Abadi, A. Agarwal, P. Barham, E. Brevdo, Z. Chen, C. Citro, G. S. Corrado, A. Davis, J. Dean, M. Devin, S. Ghemawat, I. J. Goodfellow, A. Harp, G. Irving, M. Isard, Y. Jia, R. Józefowicz, L. Kaiser, M. Kudlur, J. Levenberg, D. Mané, R. Monga, S. Moore, D. G. Murray, C. Olah, M. Schuster, J. Shlens, B. Steiner, I. Sutskever, K. Talwar, P. A. Tucker, V. Vanhoucke, V. Vasudevan, F. B. Viégas, O. Vinyals, P. Warden, M. Wattenberg, M. Wicke, Y. Yu, and

Bibliography IV

X. Zheng, "Tensorflow: Large-scale machine learning on heterogeneous distributed systems," *CoRR*, vol. abs/1603.04467, 2016.



G. E. Hinton, S. Osindero, and Y.-W. Teh, "A fast learning algorithm for deep belief nets," *Neural Computation*, vol. 18, no. 7, pp. 1527–1554, 2006.

PMID: 16764513.

M. Benammar and P. Piantanida, "Optimal training channel statistics for neural-based decoders," in *52nd Asilomar Conference on Signals, Systems, and Computers, ACSSC 2018, Pacific Grove, CA, USA, October 28-31, 2018* (M. B. Matthews, ed.), pp. 2157–2161, IEEE, 2018.

