Formalized Generalization Bounds for Perceptron-Like Algorithms

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ABSTRACT

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Insert your abstract here

DEDICATION

Dedicated to my Nathan.

Your patience, video games, and good cooking kept me going.

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Acknowledge later

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1 Introduction

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2 BACKGROUND

3 Methods

4 RESULTS

5 Conclusions

[Ros57] [MGS17] [ABR64] [LTS90] [CCBG07] [DSSS07] [CKS03] [OKC09] [BS19] [BF16] [TD05] [LBBH98] [Var16]

REFERENCES

- [ABR64] M. A. Aizerman, E. M. Braverman, and L. I. Rozoner. Theoretical foundations of the potential function method in pattern recognition learning. *Automation and Remote Control*, 25:821–837, 1964.
 - [BF16] Adrien Bibal and Benoit Frénay. Interpretability of machine learning models and representations: an introduction. In *ESANN'16 Proceedings*, Bruges, 2016.
 - [BS19] Alexander Bagnall and Gordon Stewart. Certifying the true error: machine learning in coq with verified generalization guarantees. In *Proceedings of AAAI'19*, pages 2662–2669, Hawaii, 2019.
- [CCBG07] Giovanni Cavallanti, Nicolo Cesa-Bianchi, and Claudio Gentile. Tracking the best hyperplane with a simple budget perceptron. *Machine Learning*, 69(23):143–167, 2007.
 - [CKS03] Koby Crammer, Jaz Kandola, and Yoram Singer. Online classification on a budget. In *Advances in Neural Information Processing Systems 16*. Proceedings of NIPS 2003, 2003.
- [DSSS07] Ofer Dekel, Shai Shalev-Shwartz, and Yoram Singer. The forgetron: a kernel-based perceptron on a budget. *SIAM Journal on Computing*, 37(5):1342–1372, 2007.
- [LBBH98] Yann LeCun, Léon Bottou, Yoshua Bengio, and Patrick Haffner. Gradient-based learning applied to document recognition. In *Proceedings of the IEEE*, volume 86(11), pages 2278–2324, 1998.
 - [LTS90] Esther Levin, Naftali Tishby, and S. A. Solla. A statistical approach to learning and generalization in layered neural networks. In *Proceedings of the IEEE*, volume 78, pages 1568–1574, 1990.
- [MGS17] Charlie Murphy, Patrick Gray, and Gordon Stewart. Verified perceptron convergence theorem. In *MAPL'17*, Barcelona, 2017.
- [OKC09] Francesco Orabona, Joseph Keshet, and Barbara Caputo. Bounded kernel-based online learning. *Journal of Machine Learning Research*, 10(11):2643–2666, 2009.
 - [Ros57] Frank Rosenblatt. The perceptron, a perceiving and recognizing automaton. *Report: Cornell Aeronautical Laboratory*, 58(460), 1957.
 - [TD05] Brian. J. Taylor and Marjorie A. Darrah. Rule extraction as a formal method for the verification and validation of neural networks. In *Proceedings of IEEE*

International Joint Conference on Neural Networks 2005, pages 2915–2920, Montreal, 2005.

[Var16] Kush R. Varshney. Engineering safety in machine learning. In 2016 Information Theory and Applications Workshop, La Jolla, California, 2016.