

Testing Deep Neural Networks

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Abstract. The objective of this internship is to develop a prototype platform for testing Deep Neural Networks (DNN). The tool should provide test cases ensuring a "sufficient" coverage of the DNN.

Keywords: Deep Neural Networks, Software Testing, Coverage Criteria

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1 Context

Nowadays, Neural Networks are used in many situations and tend to get an important place among software applications. However current testing techniques, e.g. functional or structural testing are not adapted for such systems.

2 Subject

The first objective of the internship is to study the state of the art of DNN testing methods. Current testing approaches are generally not adapted for DNN testing, but some preliminary works have been published [1–3]. They propose new coverage criteria for ReLU DNN inspired from usual coverage criteria (e.g. all instructions, all branches, MCDC), and compare them.

The second objective of this internship consists of developing a platform prototype implementing some of the criteria proposed in the literature. For this purpose constraint solving tools would be probably necessary [4], and an approach considering tools like Diversity [5] could be considered. The objective of this work is to develop a platform for DNN testing based on the concept of "plugin", in which future research on this domain (e.g. news covering criteria) could be integrated later.

Finally, the proposition of additional new criteria (and their implementation) will be considered and directions for a preliminary global testing methodology should be discussed.

3 International collaboration

This work will be co-advised with Omer Nguena-Timo (Centre de Recherche en Informatique de Montral).

References

1. Sun, Y., Huang, X., Kroening, D., Sharp, J., Hill, M., Ashmore, R.: Testing deep neural networks. arXiv preprint arXiv:1803.04792 (2018)
2. Sun, Y., Huang, X., Kroening, D., Sharp, J., Hill, M., Ashmore, R.: Structural test coverage criteria for deep neural networks. *ACM Transactions on Embedded Computing Systems (TECS)* **18** (2019) 1–23
3. Sun, Y., Wu, M., Ruan, W., Huang, X., Kwiatkowska, M., Kroening, D.: Concolic testing for deep neural networks. In: *Proceedings of the 33rd ACM/IEEE International Conference on Automated Software Engineering*. (2018) 109–119
4. Katz, G., Barrett, C., Dill, D.L., Julian, K., Kochenderfer, M.J.: Reluplex: An efficient smt solver for verifying deep neural networks. In: *International Conference on Computer Aided Verification*, Springer (2017) 97–117
5. Arnaud, M., Bannour, B., Lapitre, A.: An illustrative use case of the diversity platform based on uml interaction scenarios. *Electronic Notes in Theoretical Computer Science* **320** (2016) 21–34