A Replication of ‘DeepBugs: A Learning Approach to Name-based Bug Detection’

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ABSTRACT

We replicated the main result of *DeepBugs*, a bug detection algorithm for name-based bugs. The original authors evaluated it in three contexts: swapped-argument bugs, wrong binary operator, and wrong binary operator operands. We followed the algorithm and replicated the results for swapped-argument bugs. Our replication used independent implementations of the major components: training set generation, token vectorization, and neural network data pipeline, model, and loss function. Using the same dataset and the same testing process, we report comparable performance: within 2% of the accuracy reported by Pradel and Sen.

CCS CONCEPTS

• **Software and its engineering** → *Software maintenance tools; Software verification and validation.*

KEYWORDS

Defect detection, replication, machine learning, deep learning

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1 THE DEEPBUGS ALGORITHM

The DeepBugs algorithm [2] is a means by which to identify *name-based bugs* (1). These bugs are cases where a developer uses the wrong symbols — e.g., variable names — in a context, such as invoking a function with arguments in the wrong order. Supposing that developers choose meaningful variable names [1], name-based

bugs can be detected by identifying contexts where variable names are used inconsistently with learned semantic meanings.

Figure 1: DeepBugs expresses software using an abstract syntax tree, embedded as semantic vectors via Word2Vec. A neural network checks if meanings match usage contexts.

2 REPLICATION

We implemented the DeepBugs algorithm, sharing dependencies on Acorn, TensorFlow/Keras, and the dataset ([3]). The dataset is already partitioned into training and evaluation categories. We used the authors’ hyperparameters where possible, although the authors did not report RNG seeds. Beyond this, due to a clerical error, we used a Word2Vec window size of 200 tokens rather than 20 tokens.

As shown in Table 1, our results [4] match the original [2].

Table 1: Swapped-argument performance in our replication.

Step	Comparison Metric	Original VS Replication
1 & 2	Token vocabulary size	Close (“10K” vs. 9,994)
	Extracted token values	Identical
3	Generated vectors	Close (possibly affected by window size and RNG seed)
4	Training Loss	Close: ~0.002 VS ~0.002
	Test Error	Close: ~0.04 VS ~0.06

REFERENCES

- [1] A. Hindle, E.T. Barr, Z. Su, M. Gabel, and P. Devanbu. 2012. On the Naturalness of Software. In *Proceedings of the 34th International Conference on Software Engineering (Zurich, Switzerland) (ICSE ’12)*. IEEE Press, 837–847. <https://doi.org/10.1109/ICSE.2012.6227135>
- [2] M. Pradel and K. Sen. 2018. DeepBugs: a learning approach to name-based bug detection. *Proceedings of the ACM on Programming Languages* (2018). <https://doi.org/10.1145/3276517>
- [3] V. Raychev, P. Bielik, M. Vechev, and A. Krause. 2016. Learning programs from noisy data. *ACM SIGPLAN Notices* 51, 1 (Jan. 2016), 761–774. <https://doi.org/10.1145/2837614.2837671>
- [4] J. Winkler, A. Abhimanyu, C. Tung, D.R. Ugalde, Y.J. Jung, and J.C. Davis. 2021. DeepBugs Jr. Artifact. <https://doi.org/10.5281/zenodo.5110878>

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