ACETONE: Predictable Programming Framework for ML Applications in Safety-Critical Systems (Artifact)

Iryna De Albuquerque Silva
ONERA, Toulouse, France

Thomas Carle
IRIT – Univ Toulouse 3 – CNRS, France

Adrien Gauffriau
Airbus, Toulouse, France

Claire Pagetti
ONERA, Toulouse, France

Abstract

Machine learning applications have been gaining considerable attention in the field of safety-critical systems. Nonetheless, there is up to now no accepted development process that reaches classical safety confidence levels. This is the reason why we have developed a generic programming framework called ACETONE that is compliant with safety objectives (including traceability and WCET computation) for machine learning. More practically, the framework generates C code from a detailed description of off-line trained feed-forward deep neural networks that preserves the semantics of the original trained model and for which the WCET can be assessed with OTAWA. We have compared our results with Keras2c and uTVM with static runtime on a realistic set of benchmarks.

2012 ACM Subject Classification Computer systems organization → Real-time systems; Software and its engineering → Software notations and tools

Keywords and phrases Real-time safety-critical systems, Worst Case Execution Time analysis, Artificial Neural Networks implementation

Digital Object Identifier 10.4230/DARTS.8.1.6

Funding This project received funding from the French "Investing for the Future – PIA3" program within the Artificial and Natural Intelligence Toulouse Institute (ANITI).

Related Article Iryna De Albuquerque Silva, Thomas Carle, Adrien Gauffriau, and Claire Pagetti, "ACETONE: Predictable Programming Framework for ML Applications in Safety-Critical Systems", in 34th Euromicro Conference on Real-Time Systems (ECRTS 2022), LIPIcs, Vol. 231, pp. 3:1–3:19, 2022. https://doi.org/10.4230/LIPIcs.ECRTS.2022.3

Related Conference 34th Euromicro Conference on Real-Time Systems (ECRTS 2022), July 5–8, 2022, Modena, Italy

1 Scope

This artifact aims to present the approach followed to automatically generate C code describing the inference phase of neural networks models within both Keras2C and ACETONE frameworks as well as to verify the semantic preservation of the produced code, as described in Sections 4.2 and 5 of the related paper. In a first place, a minimal reproducible example is created. Then, instructions are given in order to partially reproduce the experiments and validate the results presented in Table 1 of the paper.

2 Content

The artifact package includes:

Dagstuhl Artifacts Series
Schloss Dagstuhl – Leibniz-Zentrum für Informatik,
Dagstuhl Publishing, Germany

- a Docker image with a working environment containing the source code and all the necessary tools and packages;
- a `README.md` main file with detailed instructions on how to run the Docker image and execute the experiments.

3 Getting the artifact

The artifact endorsed by the Artifact Evaluation Committee is available free of charge on the Dagstuhl Research Online Publication Server (DROPS). In addition, the artifact is also available at: `https://github.com/idealbuq/NNCodeGenerator.git`.

4 Tested platforms

This artifact is provided as a lightweight Docker image thus any platform and operating system capable of running it should perform fine. No particular amounts of memory or processor cores are required.

5 License

The artifact is available under license LGPLv3.

6 MD5 sum of the artifact

41ab74c69d68149a2c966faa52ac59bf

7 Size of the artifact

1.3 GiB