Master Internship — 5 to 6 months, starting between January and March 2026

ENGAGE - ENerGy efficiency through softwAre GEnetic improvement

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Keywords Energy-efficiency, Genetic Improvement, Code Refactoring, Software engineering.

Context. Energy efficiency has already been considered for many years at the hardware level. However, powerful and cheaper computing resources have led to less resource optimization in software. Considering the planet resource limits and the increasing role of software in the distributed systems, there is an urgent need to design software with energy-efficiency as a requirement. On the other hand, Genetic Improvement (GI) aims to improve the quality of existing software by using search-based techniques. Gin is a GI toolbox for Java that was used for software repair and run-time performance. Gin was recently extended to improve software according to multiple objectives, *e.g.,* execution time and memory usage.

Internship objectives. In the context of this internship, we would like to introduce a tool-supported approach that leverages GI to improve the **energy efficiency** of software.

To do that, we first plan to perform an empirical study to understand the extent to which other qualities, *e.g.,* minimising CPU or memory consumption, contribute to reducing the energy consumption of software. Next, we plan to extend the Gin toolbox to integrate new operators, inspired by energy-efficient tactics such as code refactoring, into the evolutionary process implemented by Gin. This extension will keep the aforementioned qualities as fitness functions. Finally, an experimental study will be conducted to evaluate the effectiveness of these operators in saving energy consumption.

In a revised version of the proposal, we plan to adapt the search-based algorithms of Gin to support a fitness function aimed at "minimising the energy consumed by the software".

Concretely the tasks that will be carried by the selected candidate:

1. Study the Genetic Improvement approach [3, 4], the Gin toolbox [2] and energy-aware code refactoring approaches, *e.g.,* [1].
2. Extend the Gin toolbox for improving the energy efficiency of software .
3. Conduct experimental studies.

Terms and conditions

— Production of open source documentation and code (licenses: GFDL and LGPL).
— Preference for using open source software.
— Version control with the GitLab platform of Télécom SudParis.

References

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[3] Justyna Petke, Saemundur O. Haraldsson, Mark Harman, William B. Langdon, David Robert White, and John R. Woodward. Genetic improvement of software: A comprehensive survey. *IEEE Trans. Evol. Comput.*, 22(3):415–432, 2018.

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