Master Internship — 5 to 6 months, starting between Feb. and Apr. 2024

ENGAGE - ENerGy efficiency through softwAre GEnetic improvement

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Keywords Energy-efficiency, Software engineering, Genetic Improvement.

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.

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. This internship will investigate how a tool-supported approach may benefit of GI to improve software energy efficiency. To do that, we plan to extend the Gin toolbox by integrating three main concepts: **i) Energy consumption profiler**: we integrate an energy profiling tool, *e.g.,* JoularJX, to identify the most energy-greedy methods in a software product, which will be the target of GI. The profiler is also needed to evaluate the fitness function of search-based algorithms. **ii) Energy efficiency tactics**: we add other mutation operators to Gin, they refer to code tactics that were proven to save energy consumption, *e.g.,* code refactoring and changes to data structure. **iii) Energy efficiency fitness function**: the search-based algorithms of Gin are adapted to support the following fitness function: "minimise energy consumed by software".

Concretely the tasks that will be carried out by the selected candidate are the following:

1. Study energy-aware refactoring approaches, *e.g.,* [1].
2. Study the Genetic Improvement approach [3, 4].
3. Explore and experiment with the Gin toolbox [2].
4. Extend the Gin toolbox for software energy efficiency.

This subject is part of the research works of the DiSSEM group concerning Distributed Systems, Software Engineering and Middleware, in the ACMES team of the SAMOVAR lab.

References

[1] Rodrigo Morales, Rubén Saborido, Foutse Khomh, Francisco Chicano, and Giuliano Antoniol. EARMO: an energy-aware refactoring approach for mobile apps. *IEEE Trans. Software Eng.*, 44(12):1176–1206, 2018.

[2] Justyna Petke and Alexander E. I. Brownlee. Software improvement with gin: A case study. In Shiva Nejati and Gregory Gay, editors, *Search-Based Software Engineering - 11th International Symposium, SSBSE 2019, Tallinn, Estonia, August 31 - September 1, 2019, Proceedings*, volume 11664 of *Lecture Notes in Computer Science*, pages 183–189. Springer, 2019.

[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.

[4] Shengjie Zuo, Aymeric Blot, and Justyna Petke. Evaluation of genetic improvement tools for improvement of non-functional properties of software. In Jonathan E. Fieldsend and Markus Wagner, editors, *GECCO '22: Genetic and Evolutionary Computation Conference, Companion Volume, Boston, Massachusetts, USA, July 9 - 13, 2022*, pages 1956–1965. ACM, 2022.