Challenges in Systems Programming: Energy Efficiency

Advanced Systems Programming (H) 2023-2024 – Laboratory Exercise 2

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1 Introduction

The Advanced Systems Programming (H/M) course uses the Rust programming language to illustrate several topics in systems programming. However, as programmers you will need to develop critical thinking skills that challenge when a language is suitable for the software being developed. To assist this learning, this exercise is introducing the concept of energy efficiency of a language. **This is a formative exercise and is not assessed.**

The use of a programming language can potentially affect the energy efficiency of the final software solution. This is due to the often unseen components of the developed software, like the compiler. These can affect the final body of assembly instructions generated, the number of data transitions in an out of CPU, as well as the basic memory footprint, and these factors, along with others, has the potential to affect the carbon footprint of the resulting system. This exercise is exploring these issues through reading and discussion in groups.

2 Formative Exercises

To improve your critical reasoning about programming languages such as C and Rust, complete the following exercises. These exercises are not assessed, and you do not need to submit your solutions.

1. Organise yourselves into small groups.
2. Use a search engine or the library's resources to answer the question "is C more energy efficient compared to other programming languages?" Think about the energy usage of the C programming language and its runtime and compare it the energy usage of alternatives such as Java or Python. Which is most efficient and why? Discuss your findings and link them to the main arguments of the paper presented in the lecture today on "Programming language challenges in systems codes: why systems programmers still use C, and what to do about it" (DOI:10.1145/1215995.1216004).
3. Next, think about the broader energy usage and carbon footprint of a computing system and the network to which it is connected. Consider what fraction of the carbon footprint is affected by the execution of programs on that system, and whether the power efficiency of the programming language actually matters? (hint: think about idle power vs. active power and how much the power consumption of a device varies depending on its use; and think about "embodied carbon", that is the energy cost of manufacturing the device, as compared to the energy cost of using the device).
4. Individually, or in small groups, prepare two or three presentation slides to summarise your findings and conclusions. You'll discuss these slides during the lecture 3 discussion time next week.

Discuss your findings with the lecturer or lab demonstrators to make sure you are on the right track.