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Review on the doctoral thesis “Garbage Collection in Software Performance Engineering” by Mgr. Peter Libič

Dear Prof. Kratochvíl,

I have read and examined the thesis by Mr. Peter Libič. My review is as follows.

Thesis topic and relevance

The thesis “Garbage Collection in Software Performance Engineering” by Mr. Peter Libič addresses the performance impacts of automated memory management called Garbage Collection (GC) in modern software environments. The author tackles a practically relevant and scientifically delicate issue how to analyze and predict the impact of GC as there are usually a variety of complex implementations and influences to GC and in turn there are many GC-related influences to software performance. The thesis author employs empirical investigations to this topic and targets performance modeling considerations that are of state-of-the-art scientific quality in the area of software performance engineering and in the area of empirical experimental evaluation in particular.

Scientific merit

The core of the thesis, described in chapters 3-5, contains intricate and non-trivial empirical investigations and performance-relevant insights into GC. Overall, the scientific results have been appreciated by the research community as they appeared as part of several international publications. The highlight is the publication on which chapter 4 is based. The work was presented at the International Conference on Performance Engineering (ICPE) ’14 (having 25% acceptance rate that year) and the paper received the best research paper award of the conference.

Strengths and weaknesses, further comments and questions

Strengths:

- The work is comprised of intricate measurements and experiments throughout the thesis. The work in in the main chapters provides interesting and non-trivial insights into the performance behavior of GC.

- Especially chapter 4 constitutes a remarkable level of detail and effort for carrying out the experimental evaluations. This is evidenced by the related publication of this chapter mentioned above.

- The approach addressed in chapter 5 demonstrates in a similar way as the previous chapter how far GC can be modeled. It also provides a great level of detail in the analysis, even though the results are triggering mixed feelings.

Neutral comments:

- Some languages provide automatic reference counting (ARC) and weak references that do not increase the reference count of an object, e.g., Objective-c. This can be mentioned in the overview of the GC algorithms for the sake of completeness, but this is nothing critical.

- Some results and especially the conclusion of the thesis shed a critical light on the topic of modeling the impact of Garbage Collection. It is legitimate to obtain negative results during an investigation as it also provides a knowledge gain and scientific value. Changing the implementation to fit a given model as suggested by the author, for example, should only be the last resort. I thus suggest for the defense to let the author highlight and recommend paths for future research based specifically on his findings.

- I think a dedicated section of the thesis’s assumptions and limitation would have been beneficial to evaluate cases to which the results of the thesis can be transferred. Having discussions on this item in the respective chapters is valid as well.

Weaknesses:

- The thesis lacks in a concise statement of its contribution that clearly highlights its significance compared to existing knowledge and the state of the art. In a sense, this is connected to my next concern.

- I generally expect a thorough discussion of related work in a doctoral thesis and I feel this to be neglected in this work with merely half a page of an actual related work survey. Even though the author states that the related work in the area of performance modeling is scarce, the survey can be of a broader focus, e.g., GC performance evaluation techniques and typical characterizations of GC-related performance impacts. I recommend for the defense to ask for a more elaborate discussion on approaches analyzing GC impacts on software performance, which I am sure the author is aware of based on the frequent citations throughout the thesis.

Further questions that arose from reading the thesis and may be clarified during the defense:

- Chapter 3: I would have expected many more kinds/types of workloads. What lead to the choice and the specific design?

- Chapter 3.1: I see that the GC algorithm is non-trivial, still some elaboration is needed as to why the author comes to the conclusion that the behavior of the HotSpot VM is not very predictable. Can it be that the author is missing some performance influences that would enable to reason why the performance behaves in some unexpected manners?

- Chapter 4: Would it be possible to use the performance (execution time, …) as prediction metric given the fact that the *GC count* is predicted within reason for the IBM VM? What would be the implications and how good would be the estimated results?

- Chapter 4.2: The author previously stated that the IBM VM is simple to predict and the fairly linear measurements in this section again confirm this

statement. Can a black-box linear regression model be used here for prediction as well?

- Chapter 4 & 5: Partly a conclusion of these chapters is that it involves a great effort to model GC. Can there be some guidelines / best practices where the effort is justified?

Decision

In summary, taking into consideration the strengths, the weaknesses, and the overall presentation and relevance of this work, I can firmly state that the thesis constitutes creative scientific work and a contribution at a Ph.D. level. The thesis demonstrates that the author can identify a relevant problem, address it with state-of-the-art scientific methods, and reveal new knowledge in his field of expertise. I therefore propose the doctoral thesis of Mr. Peter Libič to be accepted and Mr. Peter Libič to be awarded with a doctoral degree.

Sincerely,

Qais Noorshams

Dr.-Ing. Qais Noorshams