Correctness Attraction: A Study of Stability of Software Behavior Under Runtime Perturbation

Benjamin Danglot
Inria, Nord Europe
Villeneuve-d'Ascq, France
benjamin.danglot@inria.fr

Philippe Preux
Universite Lille
Villeneuve-d'Ascq, France
philippe.preux@inria.fr

Benoit Baudry
Inria Rennes, Bretage Atlantique
Rennes, France
benoit.baudry@kth.se

Martin Monperrus
KTH, Royale Institure of Technology
Stockholm, Sweden
martin.monperrus@kth.cse.se

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Can the execution of software be perturbed without breaking the correctness of the output? In this paper, we devise a protocol to answer this question from a novel perspective. In an experimental study, we observe that many perturbations do not break the correctness in ten subject programs. We call this phenomenon "correctness attraction". The uniqueness of this protocol is that it considers a systematic exploration of the perturbation space as well as perfect oracles to determine the correctness of the output. To this extent, our findings on the stability of software under execution perturbations have a level of validity that has never been reported before in the scarce related work. A qualitative manual analysis enables us to set up the first taxonomy ever of the reasons behind correctness attraction.

Our contributions are:

- A novel protocol for studying the perturbability of programs. This protocol yields a high level of validity because it considers perfect correctness oracles and a systematic exploration of the perturbation space for a given set of inputs.
- A large scale set of perturbability experiments over ten programs, and two perturbation models, resulting in 2917701 perturbed executions. We observe that 67.76% of perturbed executions yield a fully correct output. This means that correctness attraction is an important phenomenon in software.
- A qualitative manual analysis of 20 locations in the considered programs that are highly perturbable. From this analysis, we propose an original taxonomy of the reasons for correctness attraction, which discusses essential yet relatively under-researched properties of programs.

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