Improving software fault injection

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2016

document version
Publisher's PDF, also known as Version of record

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SOFTWARE FAULT INJECTION

While there is a great need for fault tolerance in software systems, we still need a good way to measure fault tolerance. Software fault injection is a suitable approach to achieve this purpose. However, it is hard to perform fault injection experiments in a way that is representative of real-world faults, which is necessary to use software fault injection in a methodologically sound way.

In this dissertation, we advance the state of the art in software fault injection to allow this technique to be used to measure fault tolerance in a way that is methodologically sound as well as efficient. First, we raise the issue of fault load distortion. We show that fault activation correlates with factors that are important in defining the fault model, such as fault types and code locations with specific properties. Based on our results, we provide guidelines to minimize the impact of fault load distortion and increase the quality of fault injection experiments. Next, we present a methodology to identify silent failures in fault injection experiments. We compare the behavior of the original program with that of a faulty version. We show that silent failures are common, implying that one cannot rely on the fail-stop assumption when designing mechanisms for fault tolerance. Then, we present an approach to compare the stability of operating systems. We use a pre-test and a post-test to determine whether faults cause the system to become unstable. This allows for a meaningful comparison of the effectiveness of fault-tolerance mechanisms in operating systems. Finally, we present a methodology to run software fault injection experiments with source-level information but without the need to recompile for each experiment. Our evaluation shows that we enable high-quality fault injection experiments on large code bases at lower cost. Taken together, the contributions made in this dissertation allow software fault injection to be applied to evaluate fault-tolerance mechanisms in a way that is both methodologically sound and low-cost.

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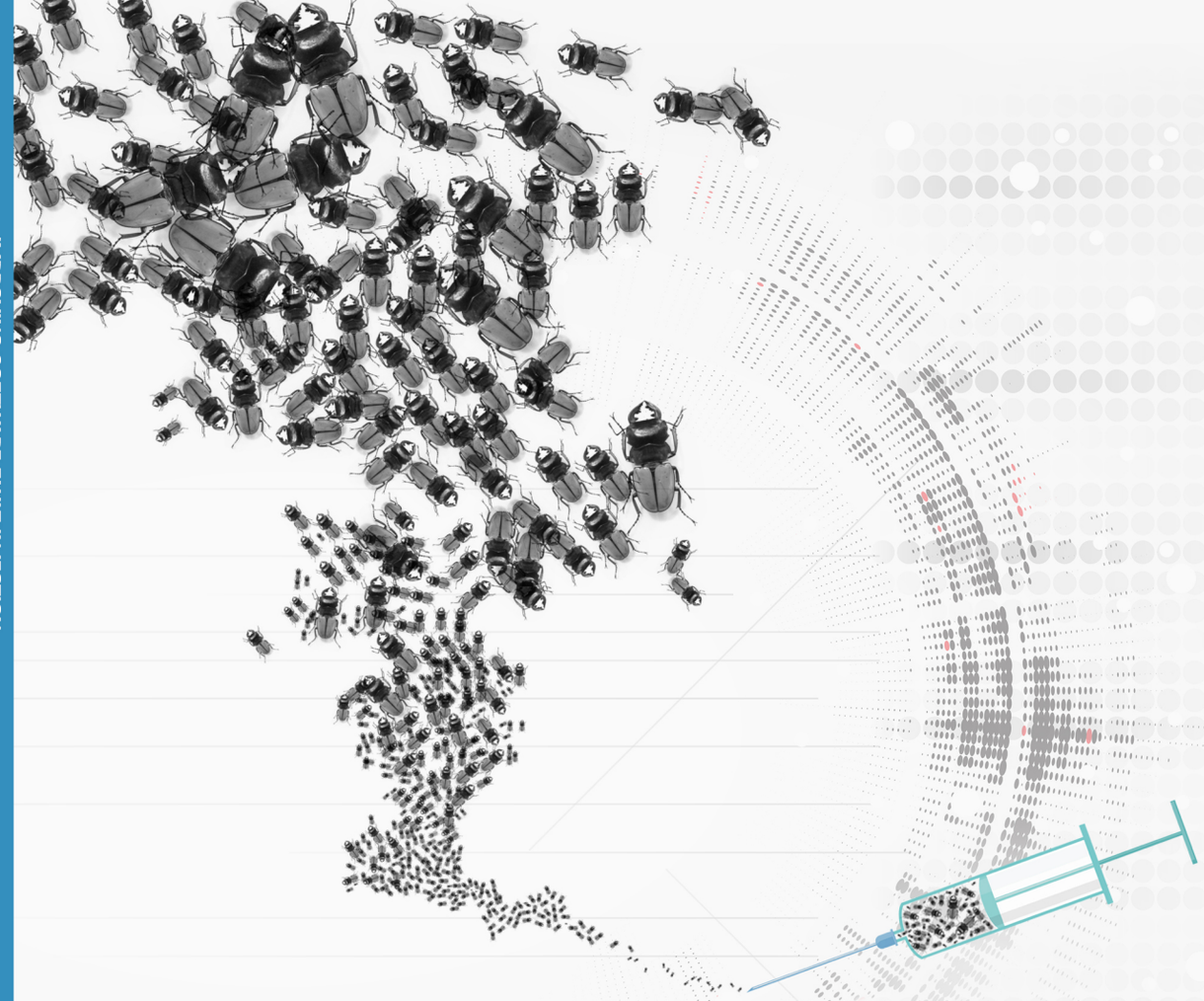

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