

Title TBD

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ABSTRACT

Due to the advancement in distributed systems and the increasing industrial demands, software systems contain multiple components with complex interactions, e.g. databases and their replication, caching components, proxies and load balancers, application instances and their complex configuration parameters. The engineers in a project must think with many configuration parameters that change the behavior and/or structure of the system, this can cause many problems that affect the quality of the service. In other words, dealing with high dimensionality is both cognitively demanding and risky for the project.

In this work we show the design and analysis of a pragmatic machine learning based tool that aims to assist the engineering of systems that can: 1) monitor themselves, 2) Forecast workloads and performance metrics and 3) Change themselves in run-time by self-configuring and adapting for a specific scenario. After the integration of this tool with a system, it should be able to answer the question: given that we have many configuration parameters, how can we change them in order to optimize a certain metric for a given predicted workload?

We show that it can decrease the risk of changing systems' configurations in run-time and decrease the engineering effort that otherwise would be spent manually optimizing parameters, usually following a trial-and-error approach.

CCS CONCEPTS

• TBD → TBD;

KEYWORDS

ACM proceedings, L^AT_EX, text tagging

ACM Reference Format:

Rodrigo Araújo and Reid Holmes. 1997. Title TBD. In *Proceedings of ACM Woodstock conference (WOODSTOCK'97)*, Rodrigo Araújo and Reid Holmes (Eds.). ACM, New York, NY, USA, Article 4, 2 pages. https://doi.org/10.475/123_4

1 INTRODUCTION

The industrial adoption of microservices has led to increasingly complex configuration schemes that are commonly fine-tuned by engineers manually. Ganek and Corbi (2003) discussed the need for autonomic computing to handle the complexity of managing software systems. They noted that managing complex systems has

become too costly, prone to error, and labor-intensive, because people under such pressure make mistakes, increasing the potential of system outages with a concurrent impact on business [cite The dawning of the autonomic computing era]. This has driven many researchers to study self-adaptive systems over the years [cite them]; however, the software industry still lacks practical tools to provide self-adaptation mechanisms to their systems. Thus, most of the configuring and tuning of the systems are performed manually, often in run-time, which is known to be a very time consuming and risky practice.

In this work we present an accessible tool to support the development of self-adaptive systems, following alternative approaches compared to what has been done before [cite papers]. The main goal is to provide such support requiring minimal effort from the engineers. In return our tool uses ideas from system observability, machine learning, and control theory to automatically assess the system's environment, predict the impact of changes that could potentially improve the system, and automatically make these changes.

Our approach consists of providing an API to collect relevant systems' metrics and configurations that represent the state of the system in relation to time. Then we map Service Level Objectives (SLOs) to some of these metrics, feed these into a machine learning component that is concurrently re-learning the model while analyzing and predicting the workload and the optimal configurations. As a result it provides adaptation plans that can be both 1) automatically executed and 2) explainable, allowing engineers to know the impact of a change in the configuration space before it is deployed.

In summary, our main contributions are:

- We provide a tool that assists the development and evolution of self-adaptive systems, regardless of the presence of self-adaptability in the system's foundations.
- We demonstrate how to map pre-existing SLAs/SLOs to optimization objectives needed by the tool.
- We present a case study that shows how an ordinary software system was improved after integrating a self-adaptation mechanism.
- We show how and why the use of self-adaptive components in ordinary software systems can improve productivity, reliability, and performance.

The rest of this paper is structured as follows: in Section 2 we discuss some past research in the space of self-adaptive systems and provide fundamental background. In Section 3 we outline our approach, explaining the blend of ideas from different fields. In Section 4 we describe internal details and design decisions of our implementation. In Section 5 we present our case study followed by a discussion and future directions in Section 6. Finally, we conclude our findings with Section 7.

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WOODSTOCK'97, July 1997, El Paso, Texas USA
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ACM ISBN 123-4567-24-567/08/06...\$15.00
https://doi.org/10.475/123_4

2 RELATED WORK

Maybe related work would be better now instead of putting it in the end, since there are a lot of related work and they are very relevant to this work, it would be nice to upfront point out what has been done and what would be different in this work.

Also include background here.

3 APPROACH

3.1 Control theory and self-adaptive systems

3.2 System's configuration as an optimization problem

3.3 Providing system adaptation with machine learning

3.4 Workload simulation

3.5 System instrumentation

3.6 Machine learning architecture

3.6.1 Features and models.

3.6.2 Online training.

3.6.3 Achieving self-adaptation.

4 IMPLEMENTATION

5 EVALUATION

6 DISCUSSION AND FUTURE WORK

7 CONCLUSIONS

ACKNOWLEDGMENTS

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