

University of Stuttgart

Representative Load Testing in Continuous Software Engineering: Automation and Maintenance Support

Henning Schulz and André van Hoorn | February 28, 2020

PART OF THE



ContinuITY Project

<https://continuity-project.github.io/>

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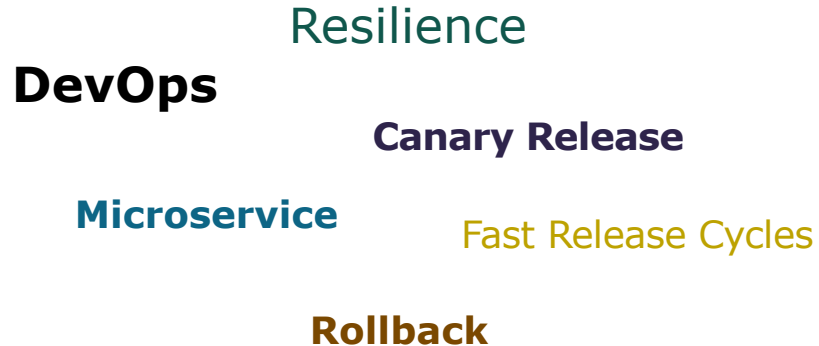


Federal Ministry
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and Research

Do We Need Load Testing in Continuous Software Engineering?

“Load testing is the process of assessing the behavior of a system under load in order to detect load-related problems.”

Jiang et al., 2015



~~Do~~ We Need Load Testing in Continuous Software Engineering!

“Load testing is the process of assessing the behavior of a system under load in order to detect load-related problems.”

Jiang et al., 2015

WEB \ TECH \ AMAZON \

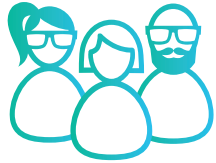
Amazon's website crashed as soon as Prime Day began

By Nick Statt | @nickstatt | Jul 16, 2018, 3:16pm EDT

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<https://www.theverge.com/2018/7/16/17577654/amazon-prime-day-website-down-deals-service-disruption>

DevOps Brings Opportunities



DevOps team



WESSBAS
(Vögele et al., 2018)



Representative
Load Test



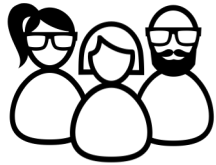
Monitored
Request logs



Schulz et al.,
LTB@ICPE 2018

...and Challenges

automated pipeline



DevOps team



long-running tests

WESSBAS
(Vögele et al., 2018)

various workload scenarios



Representative Load Test

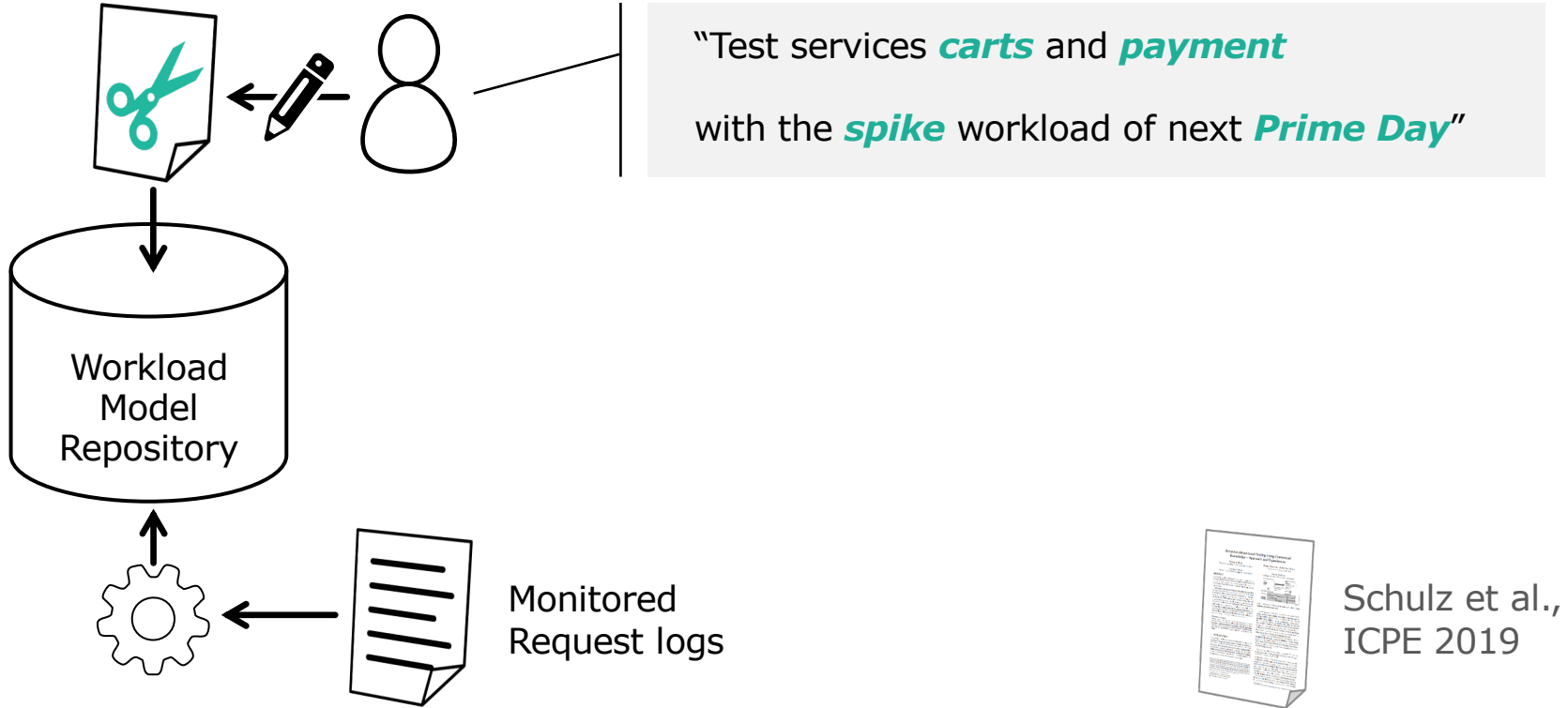


Monitored Request logs

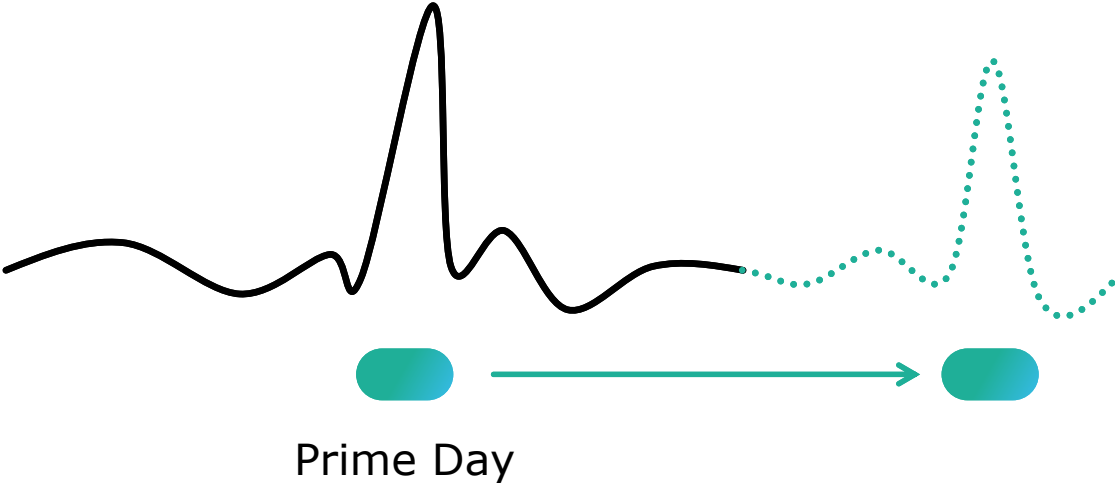


Schulz et al.,
LTB@ICPE 2018

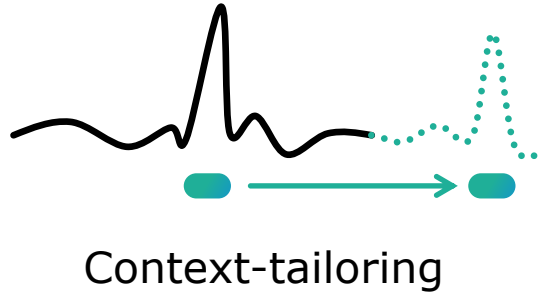
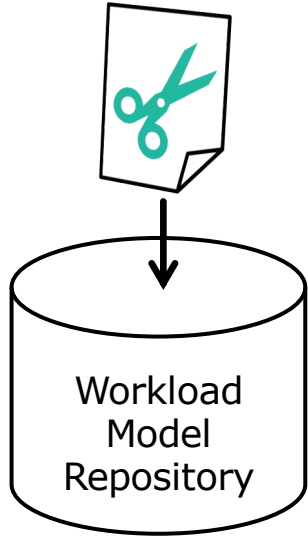
Idea: Tailored Representative Load Testing



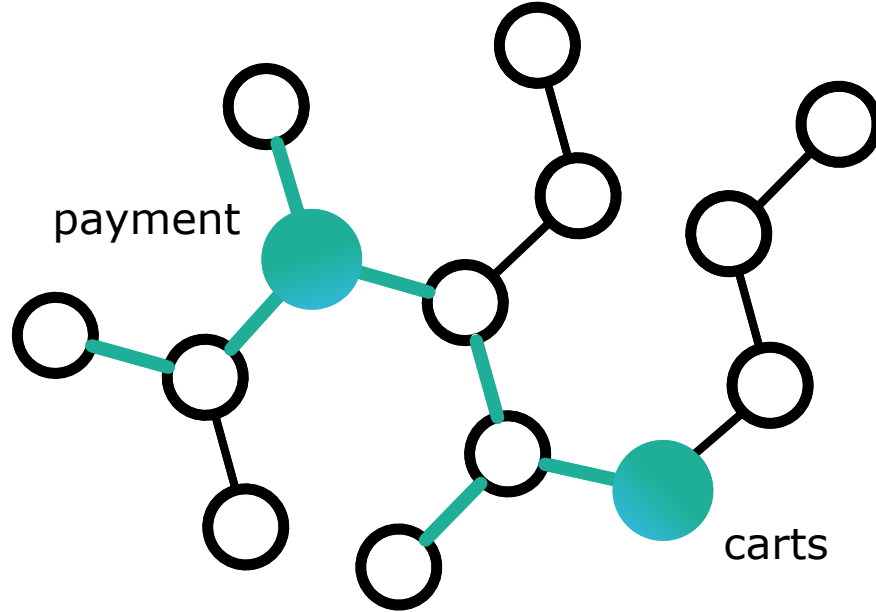
Idea: Tailored Representative Load Testing



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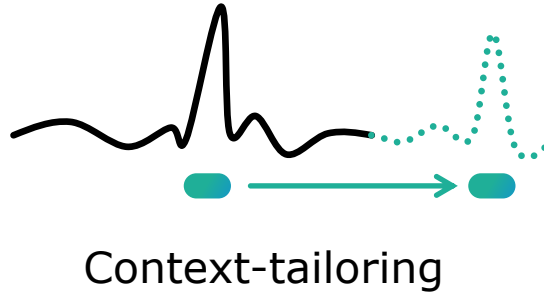
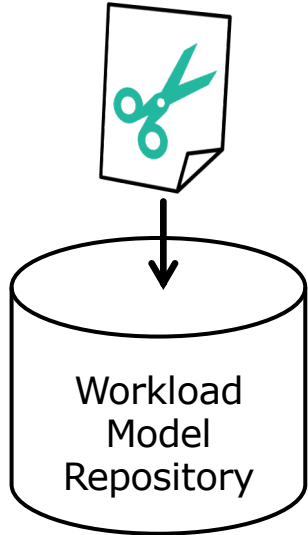


Idea: Tailored Representative Load Testing



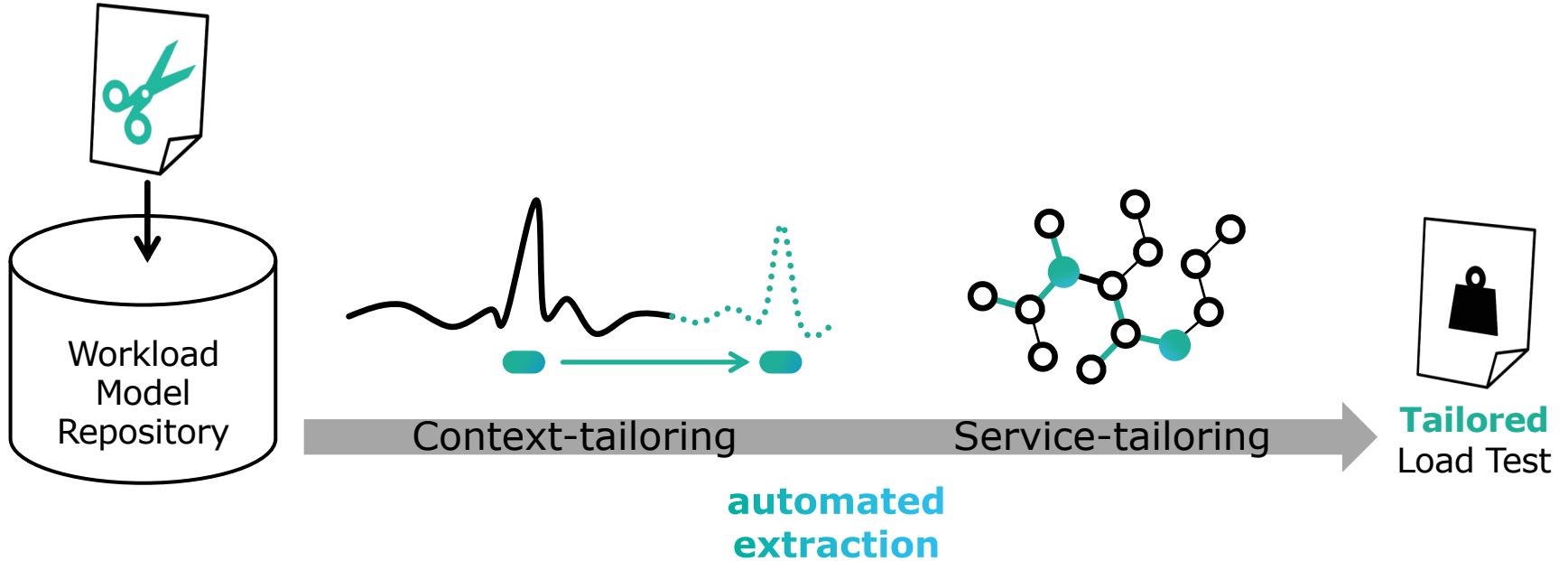
Schulz et al.,
MASCOTS 2019

Idea: Tailored Representative Load Testing

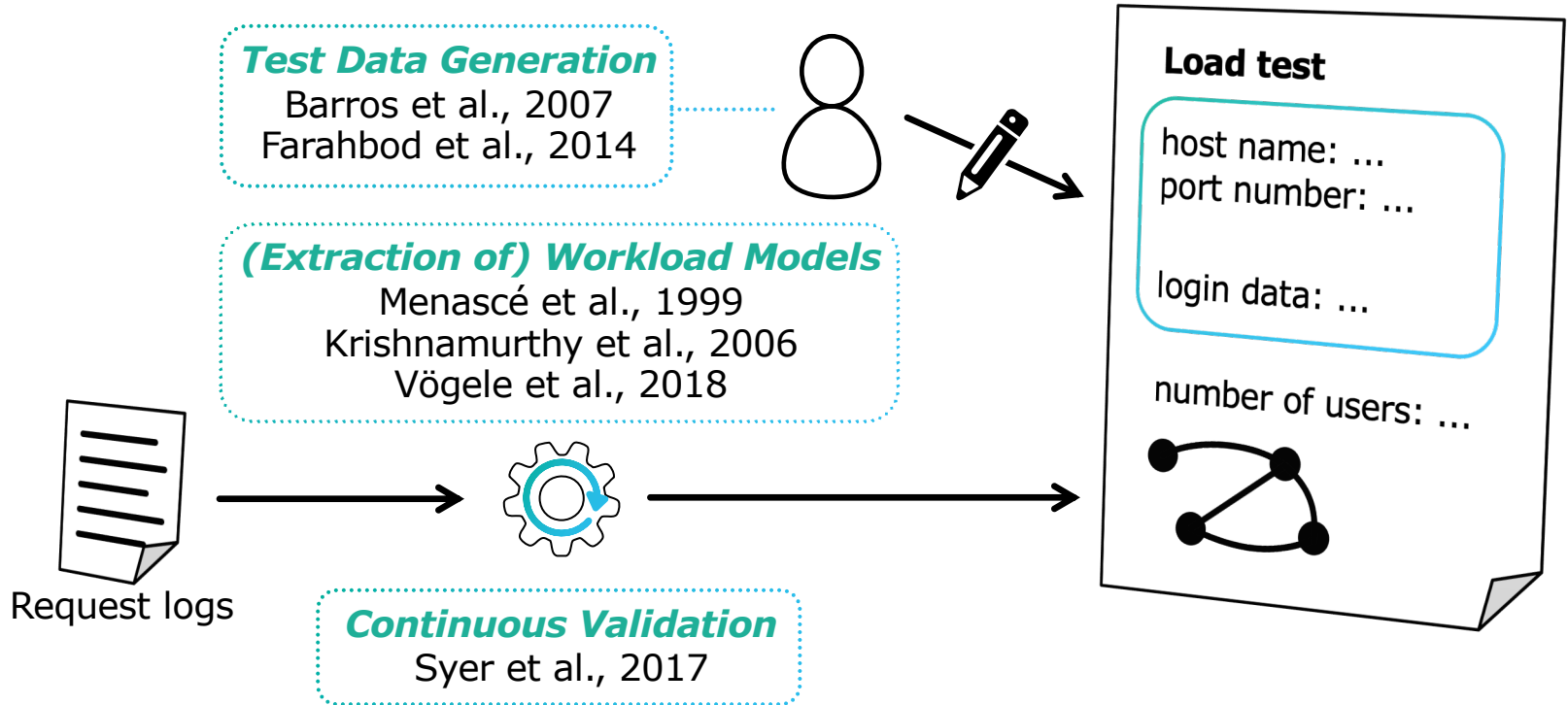


Schulz et al.,
MASCOTS 2019

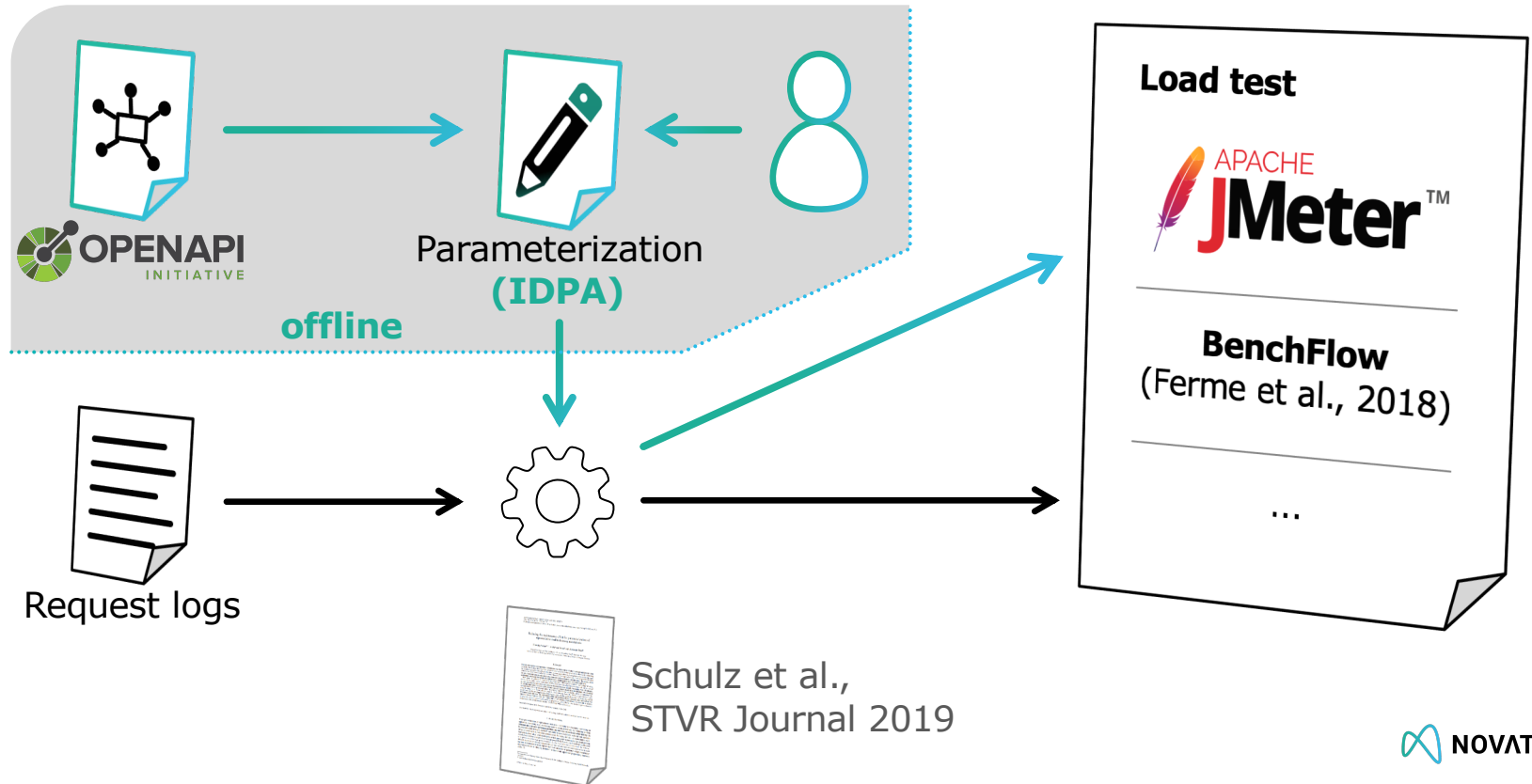
Idea: Tailored Representative Load Testing



State of the Art Lacks in Automation

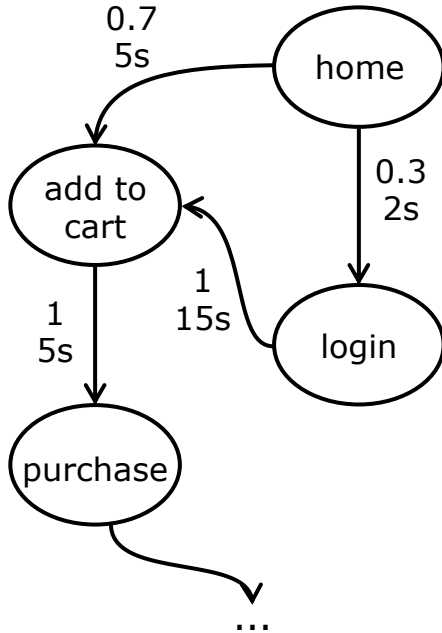


Reducing the Manual Parameterization Effort



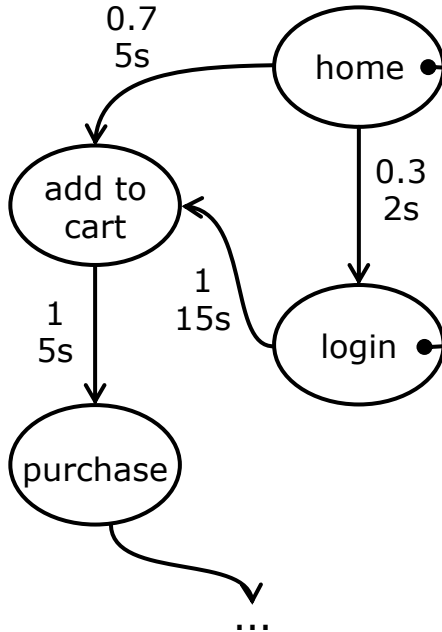
Input Data and Properties Annotation

Request Model (Markov Chain)

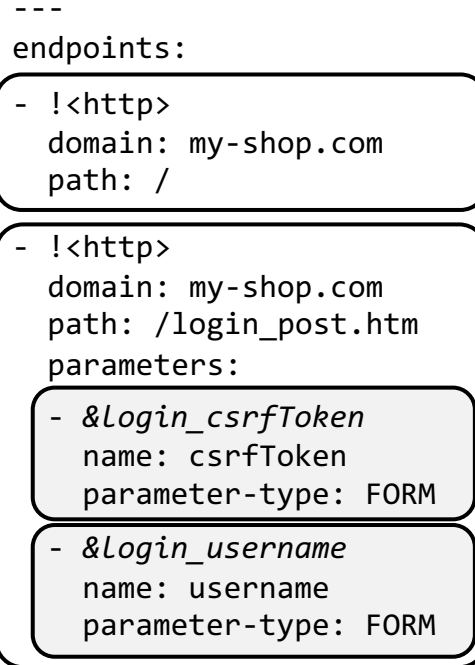


Input Data and Properties Annotation

Request Model (Markov Chain)

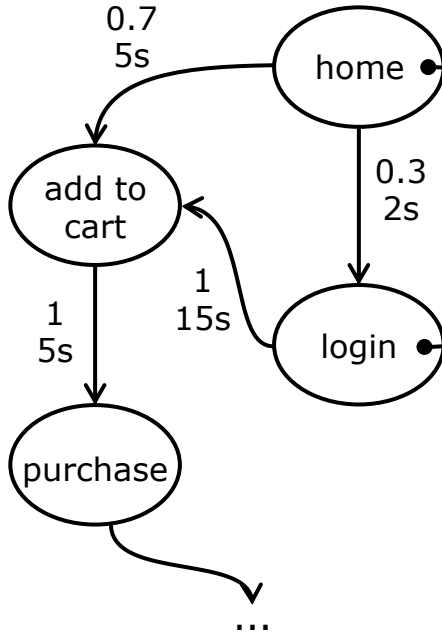


Application Model (YAML)

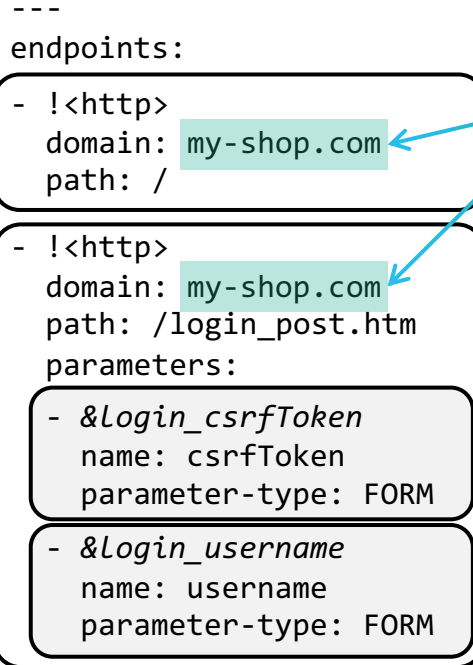


Input Data and Properties Annotation

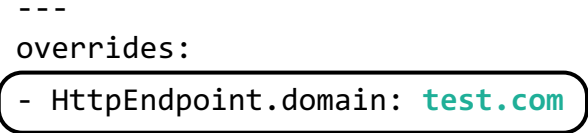
Request Model (Markov Chain)



Application Model (YAML)

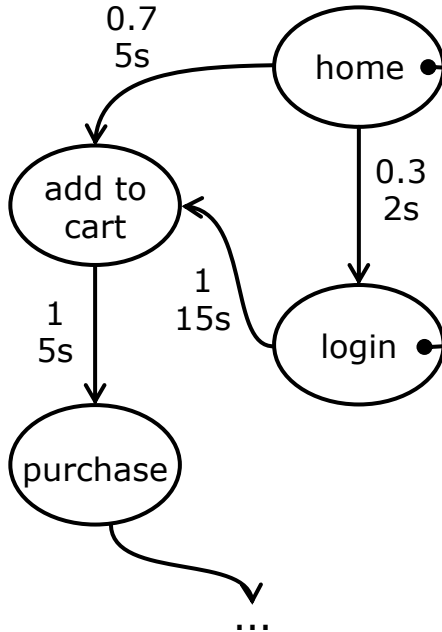


Annotation Model (YAML)

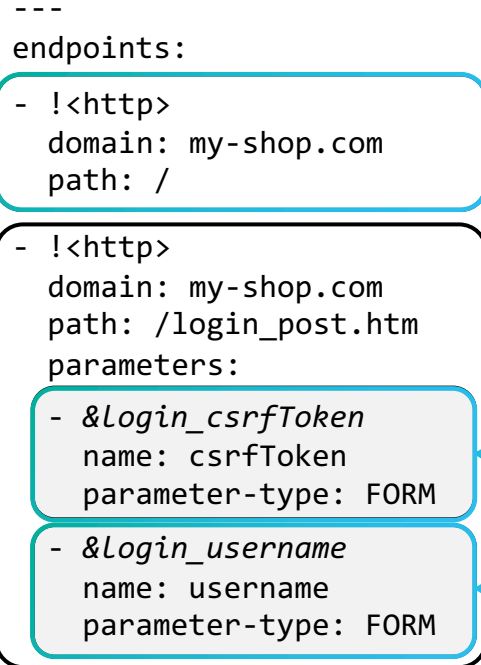


Input Data and Properties Annotation

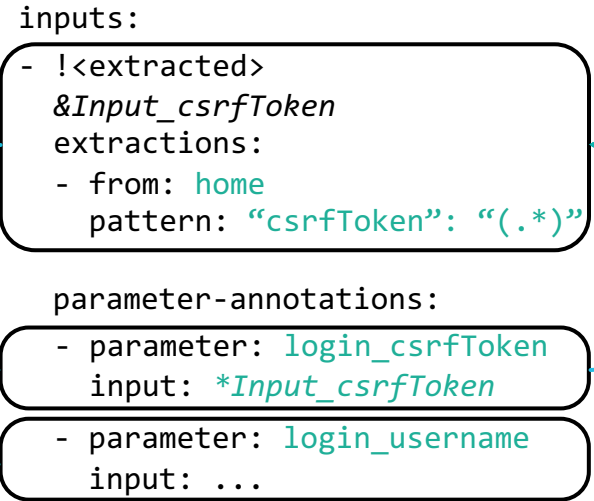
Request Model (Markov Chain)



Application Model (YAML)



Annotation Model (YAML)



Evaluation in 4 Studies

Representativeness:

- Broadleaf Heat Clinic
- Sonatype Nexus

Expressiveness:

- Industrial Case Study

Effort:

- Estimation Models



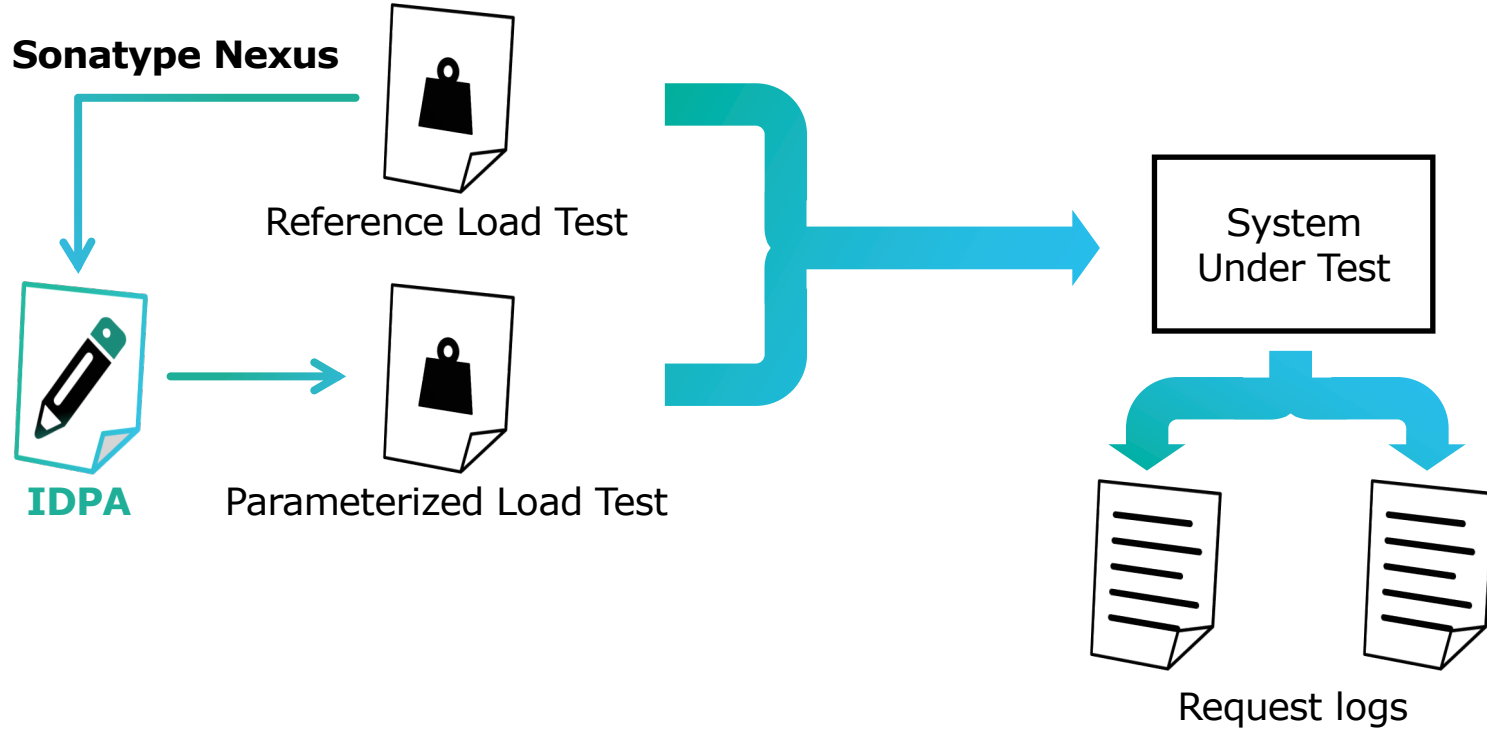
Schulz et al.,
STVR Journal 2019



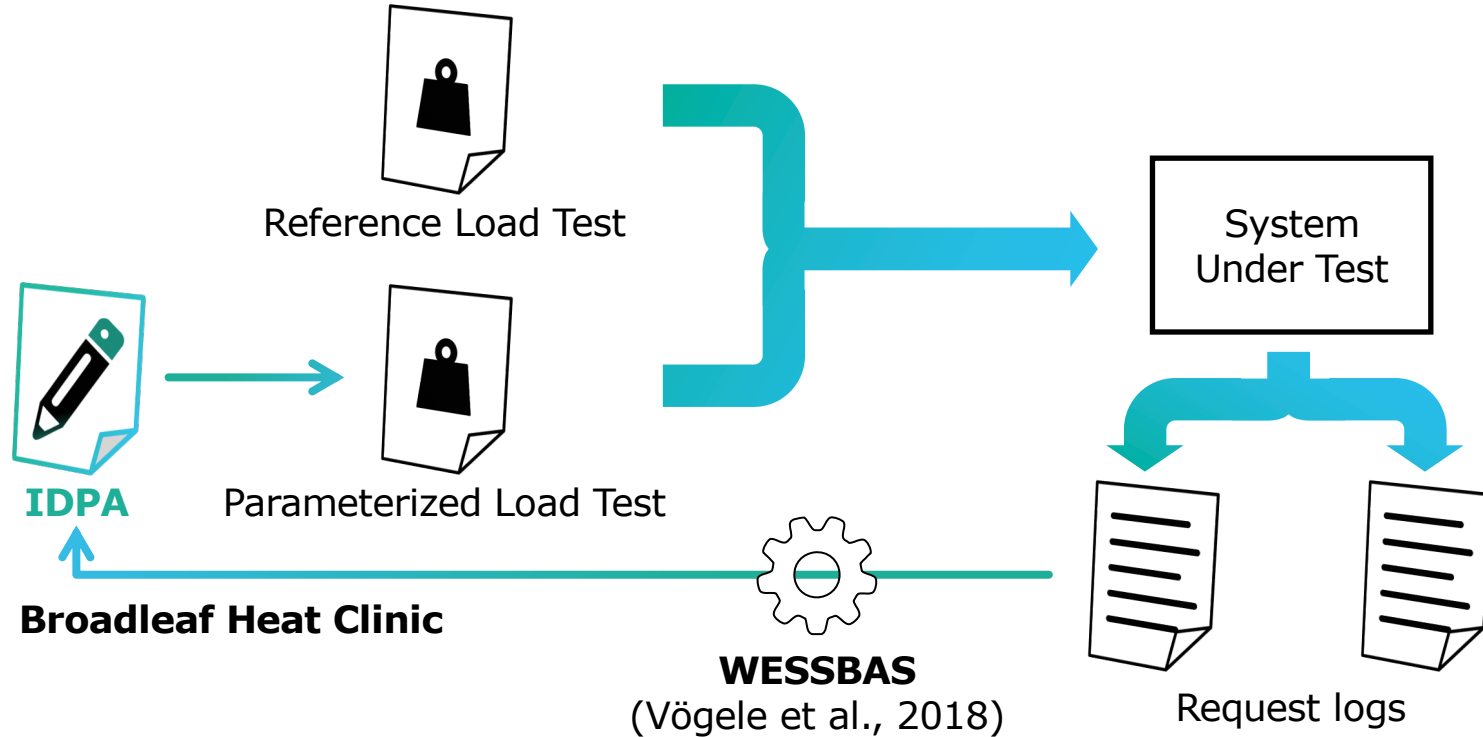
Replication Package:

<https://doi.org/10.5281/zenodo.3333366>

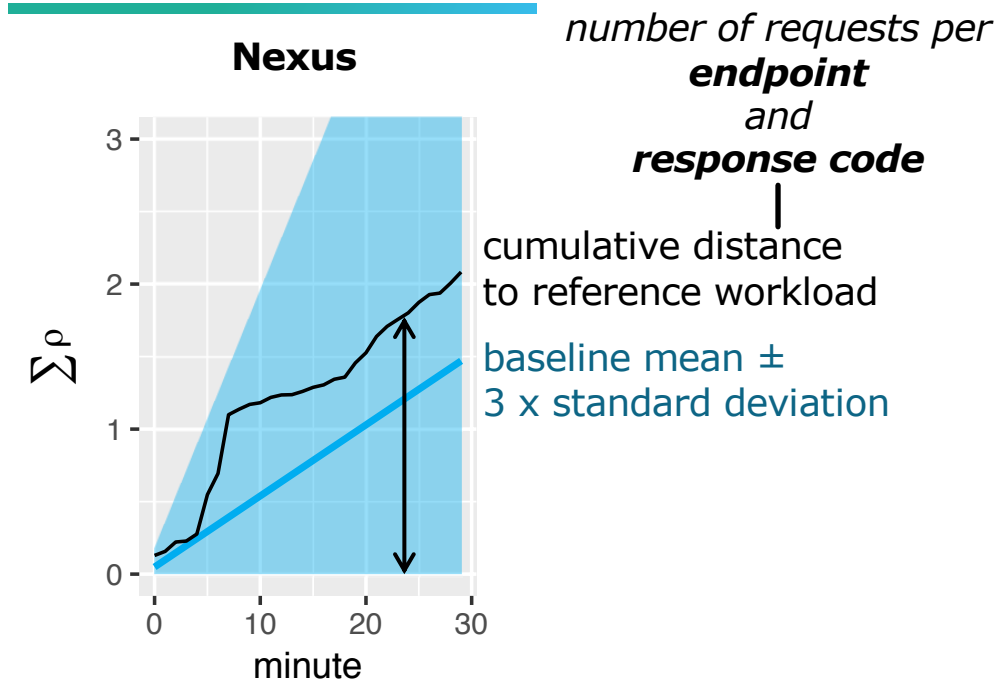
Measuring Representativeness



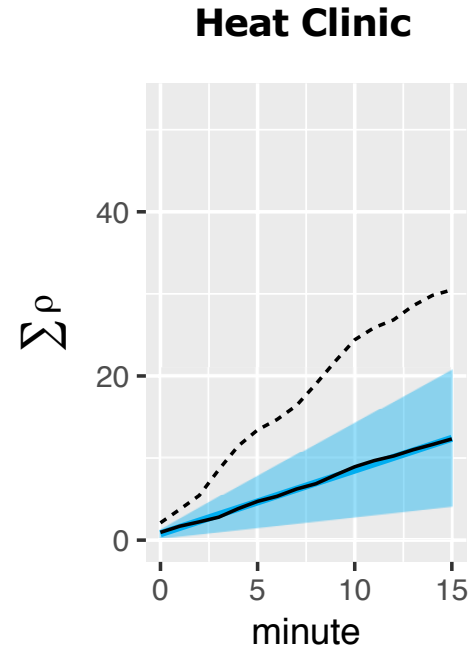
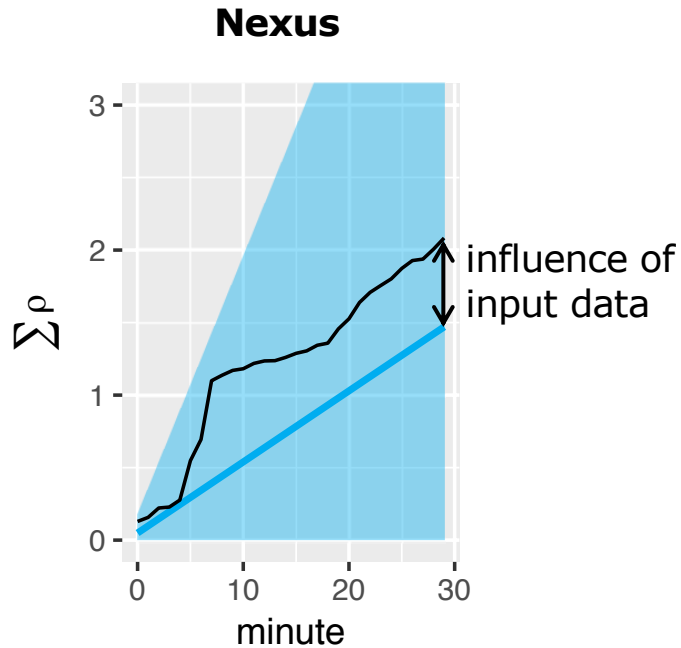
Measuring Representativeness



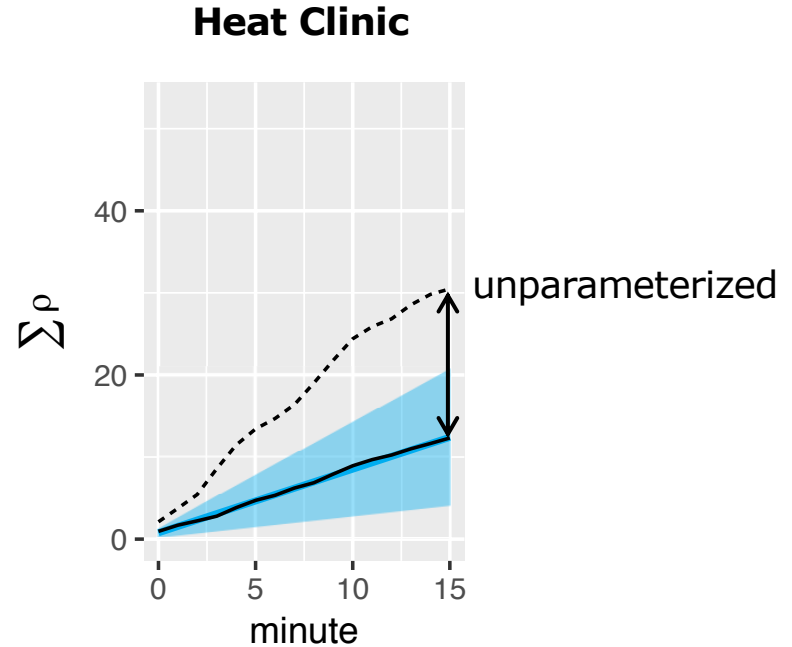
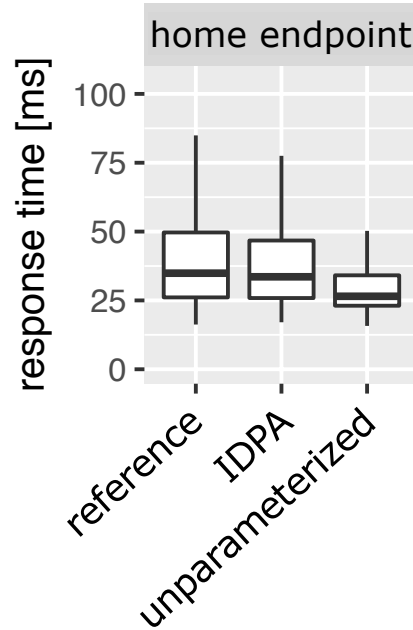
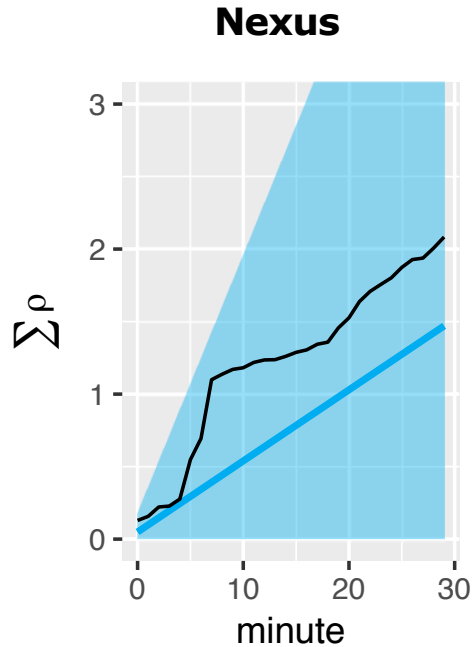
Representativeness is High for Session-dominated Workload Models



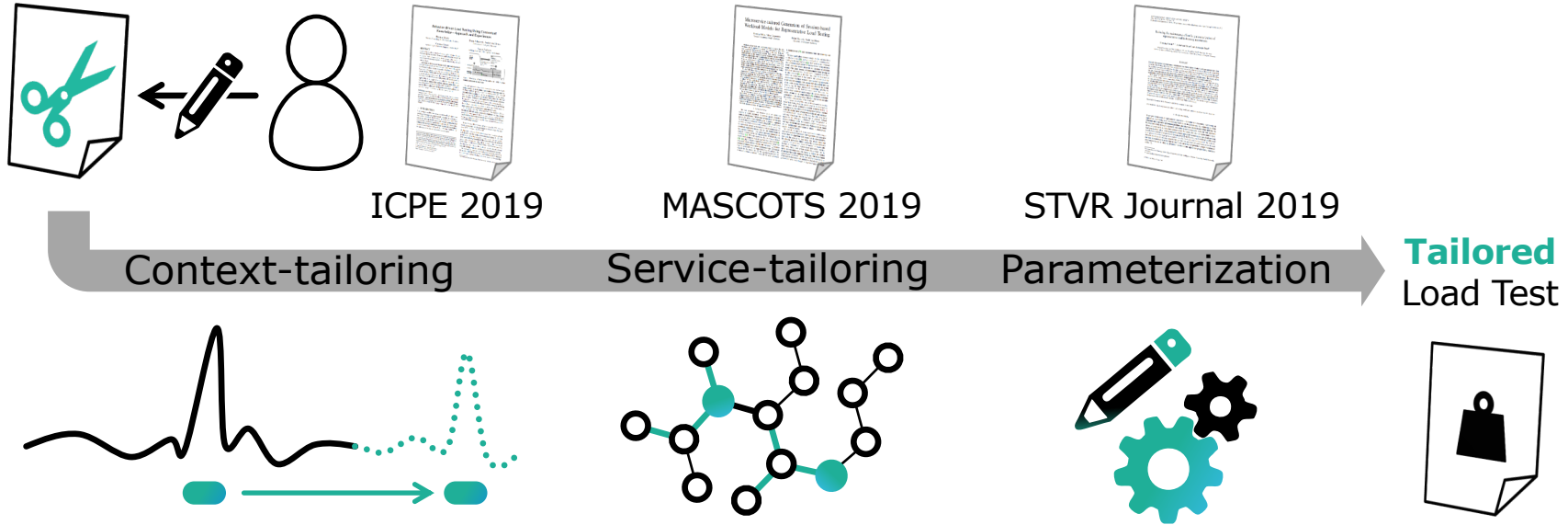
Representativeness is High for Session-dominated Workload Models



Representativeness is High for Session-dominated Workload Models



Automated Parameterization Enables Automated Load Test Tailoring



Publications

Towards Automating Representative Load Testing in Continuous Software Engineering

Henning Schulz, Tobias Angerstein, and André van Hoorn

Companion of the 9th ACM/SPEC International Conference on Performance Engineering (LTB@ICPE 2018)

Reducing the Maintenance Effort for Parameterization of Representative Load Tests Using Annotations

Henning Schulz, André van Hoorn, and Alexander Wert

Journal of Software Testing, Verification and Reliability, Special Issue on Testing Extra-functional Properties, 2019

Microservice-tailored Generation of Session-based Workload Models for Representative Load Testing

Henning Schulz, Tobias Angerstein, Dušan Okanović, André van Hoorn

Proceedings of the 27th IEEE International Symposium on Modeling, Analysis, and Simulation of Computer and Telecommunication Systems (MASCOTS 2019)

Behavior-driven Load Testing Using Contextual Knowledge – Approach and Experiences

Henning Schulz, Dušan Okanović, André van Hoorn, Vincenzo Ferme, Cesare Pautasso

Proceedings of the 10th ACM/SPEC International Conference on Performance Engineering (ICPE 2019)

References (I)

Web services wind tunnel: on performance testing large-scale stateful web services

M. D. Barros, J. Shiau, C. Shang, K. Gidewall, H. Shi, and J. Forsmann

Proceedings of the 37th Annual IEEE/IFIP International Conference on Dependable Systems and Networks (DSN 2007)

Data generation for performance evaluation

R. Farahbod and A. Dadashi

US 9,613,074 B2, 2017

A Declarative Approach for Performance Tests Execution in Continuous Software Development Environments

V. Ferme and C. Pautasso

Proceedings of 8th ACM/SPEC International Conference on Performance Engineering (ICPE 2018)

A Survey on Load Testing of Large-scale Software Systems

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IEEE Transactions on Software Engineering, vol. 41, no. 11, 2015

References (II)

A synthetic workload generation technique for stress testing session-based systems

D. Krishnamurthy, J. A. Rolia, and S. Majumdar

IEEE Transactions on Software Engineering, vol. 32, no. 11, 2006

A methodology for workload characterization of E-Commerce sites

D. A. Menascé, V. A. F. Almeida, R. Fonseca, and M. A. Mendes

Proceedings of the 1st ACM Conference on Electronic Commerce (EC 1999)

Continuous validation of performance test workloads

M. D. Syer, W. Shang, Z. M. Jiang, and A. E. Hassan

Automated Software Engineering, vol. 24, no. 1, 2017

WESSBAS: extraction of probabilistic workload specifications for load testing and performance prediction - a model-driven approach for session-based application systems

C. Vögele, A. van Hoorn, E. Schulz, W. Hasselbring, and H. Krcmar

Software and System Modeling, vol. 17, no. 2, 2018