Wellison Santos

Contact Information

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Summary

I am a researcher with $+7$ years of experience with adaptive systems. My work focuses on improving QoS in cloud-native apps. I used formal methods to auto-scaling SOA apps throughout my graduation using LTLChecker and CADP. In my MS.c., I developed a proactive system for auto-scaling microservices that uses machine learning models to forecast CPU, called ML-Adapt. ML-Adapt decreased application response time by 20% compared to HPA in best-case scenarios. In my Ph.D., I'm researching ways to improve ML-Adapt. First, I demonstrated that the Multiple Predictor System (MPS) improves microservices time-series forecasts by 35-75% in best results and works equal to or better than the previous approach in 81.5% of experiments. Currently, I'm using this finding to handle issues in microservices apps, such as cold start or auto-scaling.

Education

2020–2024[1] **Ph.D. in Computer Science:** Universidade Federal de Pernambuco[2], Recife/Brazil.

2018–2020 **MS.c. in Computer Science:** Universidade Federal de Pernambuco, Recife/Brazil.

Dissertation: Adaptation of microservices-based applications using machine learning.

2013-2017 **BS.c. in Computer Science:** Universidade do Estado do Rio Grande do Norte[3], Santa Cruz/Brazil

Final paper: A solution for runtime verification of service compositions.

Experience

2023–2024 **Visiting International Research Student at Systopia Lab:** The current project aims to design and develop a new solution for bottleneck detection in microservices, considering their inherent dynamism in production environments.

Transferable skills: Microservices, Root Cause and Anomaly Detection, Graph Neural Networks

Location: The University of British Columbia, Canada.

2018-2024 **Ph.D. and MS.c. fellow:** During my MS.c., I created ML-Adapt, a proactive system that uses machine learning to forecast CPU for auto-scaling microservices. ML-Adapt notably reduced application response time by 20% compared to HPA in best-case scenarios. However, its effectiveness relied heavily on forecast accuracy. My Ph.D. research focuses on enhancing this forecast component. I introduced the Multiple Predictors System (MPS) approach, demonstrating its superior accuracy (35-75% improvement in the best results) in 81.5% of experiments compared to the previous approach.

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[1]The completion of the Ph.D. is anticipated by **March 2024**.

[2]The computer science program ranks among the **top seven most esteemed programs in Brazil**.

[3]I graduated with academic honours and was acknowledged as **the top student in the program**.

Transferable skills: Microservices, Kubernetes, Auto-scaling, Self-adaptive Systems, Machine Learning, Time Series Forecasting, Java, Kubernetes, Python.

Location: Universidade Federal de Pernambuco, Brazil.

2017-2018 **Undergraduate research in runtime verification of service compositions:** This project aims to develop a solution supporting the development, implementation, execution, and monitoring/verification of service compositions. Due to their execution in highly dynamic business environments by different programmers, monitoring service compositions becomes crucial. Solely relying on syntactic descriptions does not ensure expected behaviour during execution, necessitating runtime monitoring. I addressed this challenge by verifying that service compositions adhere to their behavioural properties at runtime (e.g., ensuring activity B consistently follows activity A) using formal description techniques like LTLMiner and CADP.

Transferable skills: SOA, SOA Orchestration, Formal Description, Self-Adaptive Systems, Systems Modelling.

Location: Universidade do Estado do Rio Grande do Norte, Brazil.

2016-2017 **Undergraduate research in motor coordination:** This project aimed to help develop, improve, and refine motor coordination. I was responsible for creating a suite of digital games developed with augmented reality. The software aimed to stimulate children's movement, reversing the current, static and passive way. The child must identify the markings scattered around the houses that contained puzzles. Each puzzle directs the child to the next mark. In the end, the child had fun and moved around while using the device.

Transferable skills: Augmented Reality, Android, Unity.

Location: Universidade do Estado do Rio Grande do Norte.

Grants

2023-2024 **Sandwich Doctorate Fellowship** – Grant by the Brazilian CAPES (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, in Portuguese)

2020-2024 **Ph.D. Fellowship** – Grant by the Brazilian FACEPE (Fundação de Amparo à Ciência e Tecnologia do Estado de Pernambuco, in Portuguese)

2018-2020 **MS.c. Fellowship** – Grant by the Brazilian FACEPE (Fundação de Amparo à Ciência e Tecnologia do Estado de Pernambuco, in Portuguese)

2014-2017 **Teacher Assistant Fellowship for Calculation for Computing, Physics and Numerical Calculation** – Grant by the UERN college (Universidade do Estado do Rio Grande do Norte, in Portuguese)

Publications

Santos, W.; Sampaio Jr.; Rosa, N.; Cavalcanti, G. Univariate vs multivariate prediction for containerised applications auto-scaling: a comparative study. CAiSE'24. (submitted in Dec/23)

Santos, W.; Sampaio Jr.; Rosa, N.; Cavalcanti, G. Predictive models for adapting microservice-based applications: a comparative analysis. JPDC. (submitted in Aug/23)

Santos, W.; Sampaio Jr, A.; Rosa, N.; Cavalcanti, G. Microservices Performance Forecast Using Dynamic Multiple Predictor Systems. EAAI (2024). doi:https://doi.org/10.1016/j.engappai.2023.107649

Santos, W.; Xavier, M.; da Cunha, D. C.; Júnior, J. C. M.; Adauto, D.; Ferraz, C. Trendsbot: Checking the veracity of telegram messages using data streams[4]. SRBC (2019). doi:https://doi.org/10.5753/sbrc_estendido.2019.7771

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[4]The paper received an **honourable mention** award.