# Data Science Driven Methods for Sustainable and Failure Tolerant Edge Systems

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## ABSTRACT

Nowadays we experience a paradigm shift in our society, where every item around us is becoming a computer facilitating life-changing applications like self-driving cars, tele-medicine, precision agriculture or virtual reality. On one hand, for the execution of such resource demanding applications we need powerful IT facilities. On the other hand, the requirements often include latencies below 100 ms or even below 10 ms – what is called "tactile internet". To facilitate low latency computation has to be placed in the vicinity of the end users by utilizing the concept of Edge Computing. In this talk we explain the challenges of Edge systems in combination with tactile internet. We discuss the recent problems of geographically distributed machine learning applications and novel approaches to balance competing priorities like the energy efficiency and the staleness of the machine learning models.

Available failure resilience mechanisms designed for Cloud computing or generic distributed systems cannot be applied to Edge systems due to timeliness, hyper heterogeneity and resource scarcity. Therefore, we discuss a novel machine learning based mechanism that evaluates the failure resilience of a service deployed redundantly on the edge infrastructure. Our approach learns the spatiotemporal dependencies between edge server failures and combines them with the topological information to incorporate link failures by utilizing the concept of the Dynamic Bayesian Networks (DBNs). Eventually, we infer the probability that a certain set of servers fails or disconnects concurrently during service runtime.

## CCS CONCEPTS

• **Computer systems organization** → **Distributed architectures**; *Dependable and fault-tolerant systems and networks.*

## KEYWORDS

edge computing, geographically distributed machine learning, dynamic Bayesian Networks

## BIOGRAPHY

Ivona Brandic is University Professor for High Performance Computing Systems at the Institute of Information Systems Engineering, Vienna University of Technology (TU Wien) where she leads the High Performance Computing Systems Research Group.

In 2015 she was awarded the FWF START prize, the highest Austrian award for early career researchers. Since 2016 she has been a member of the Young Academy of the Austrian Academy of Sciences.

She received her PhD degree in 2007 and her venia docendi for practical computer science in 2013, both from Vienna University of Technology. From 2009 to 2012 she led the Austrian national FoSII (Foundations of Self-governing ICT Infrastructures) project funded by the Vienna Science and Technology Fund (WWTF). She was a management committee member of the European Commission's COST Action on Energy Efficient Large Scale Distributed Systems and of the COST Action on Sustainable Ultrascale Computing (NE-SUS). From June to August 2008 she was visiting researcher at the University of Melbourne, Australia. I. Brandic was on the Editorial Board of IEEE Magazine on Cloud Computing, IEEE TPDS and IEEE TCC.

In 2011 she received the Distinguished Young Scientist Award from the Vienna University of Technology for her project on the Holistic Energy Efficient Hybrid Clouds. Her interests comprise virtualized HPC systems, energy efficient ultra-scale distributed systems, massive-scale data analytics, Cloud & workflow Quality of Service (QoS), and service-oriented distributed systems. She published more than 50 scientific journal, magazine and conference publications and she co-authored a text-book on federated and self-manageable Cloud infrastructures.

I. Brandic has been invited as an expert evaluator of the European Commission, and many national research organizations. In 2019 she chaired the CHIST-ERA panel (ANR) on Smart Distribution of Computing in Dynamic Networks (SDCDN).

She is a board member of the Center for Artificial Intelligence and Machine Learning (CAIML) and a faculty member of the Vienna Center for Engineering in Medicine at TU Wien.



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