

# Enactment of Adaptation in Data Stream Processing with Latency Implications—A Systematic Literature Review

Cui Qin,<sup>1</sup> Holger Eichelberger,<sup>2</sup> Klaus Schmid<sup>3</sup>

**Abstract:** This summary refers to the paper *Enactment of adaptation in data stream processing with latency implications – A systematic literature review* [QES19]. This paper is a journal paper published in *Information and Software Technology (IST)* in July 2019.

Runtime adaptation in stream processing plays a significant role in supporting the optimization of data processing tasks. In recent years, runtime adaptation, particularly its enactment, has received significant interest in scientific literature. However, so far no categorization of the enactment approaches for runtime adaptation in stream processing has been established.

This paper presents a systematic literature review (SLR), where we identify and characterize different approaches towards the enactment of runtime adaptation in stream processing with a main focus on latency as quality dimension. We discovered 75 relevant papers out of 244 papers from the search. We identified 17 different enactment categories and developed a taxonomy to characterize all possible enactment approaches. We extracted the realization techniques of each identified enactment approach and classified them into categories. Furthermore, we identified 9 categories of processing problems, 6 adaptation goals, 9 evaluation metrics and 12 evaluation parameters from the identified enactment approaches. The research interest on enactment approaches has significantly increased in recent years. The most commonly applied enactment approaches are parameter adaptation to tune parameters or settings of the processing, load balancing used to re-distribute workloads, and processing scaling to dynamically scale up and down the processing.

**Keywords:** Stream processing; Big Data; runtime adaptation; enactment; latency; systematic literature review

In recent years, we witnessed increasing attention to data-intensive applications [CJ09; K117] such as stock trading, cyber-physical systems, social media, etc. Such applications aim at continuously providing analysis results to end-users, some even, with rather strict time constraints. In the continuous processing of data streams, the processing situations may vary over time. For example, the volume or velocity of streams can change drastically. To cope with the dynamic characteristics of data streams as well as the varying processing environment, runtime adaptation of the processing becomes critical. There are different

---

<sup>1</sup> University of Hildesheim, Institute of Computer Science, Software Systems Engineering, Universitätsplatz 1, 31141 Hildesheim, Germany qin@sse.uni-hildesheim.de

<sup>2</sup> University of Hildesheim, Institute of Computer Science, Software Systems Engineering, Universitätsplatz 1, 31141 Hildesheim, Germany eichelberger@sse.uni-hildesheim.de

<sup>3</sup> University of Hildesheim, Institute of Computer Science, Software Systems Engineering, Universitätsplatz 1, 31141 Hildesheim, Germany eichelberger@sse.uni-hildesheim.de

ways of adapting the processing behavior in literature. However, so far no categorization for runtime adaptation in stream processing has been established.

In [QES19], we present a systematic literature review to identify and characterize different approaches for the enactment of runtime adaptation in stream processing with a main focus on latency as quality dimension. Our study aims to identify the existing enactment approaches for runtime adaptation and categorizing them into a taxonomy. Moreover, we analyze each enactment approach by extracting their realization techniques, their addressed problems, goals as well as their evaluation focus. We target the following main research questions:

**RQ1.** In studies analyzing adaptation in data stream processing from a latency perspective, which enactment approaches exist?

**RQ2.** What techniques are used to realize which enactment?

We discovered 244 relevant papers out of which 75 were categorized as relevant. As the result of **RQ1**, we identified 17 categories of enactment approaches and provided a taxonomy classifying them from the perspective of resource, data, and processing. We summarized the frequency of the papers in which the enactment approach is proposed or applied. We identified that the most commonly applied enactment approaches are Parameter Adaptation to tune parameters or settings of the processing, Load Balancing used to re-distribute workloads, and Processing Scaling to dynamically scale up and down the processing. Furthermore, for each enactment approach we identified the underlying realization techniques to gain insight into the diverse realizations of adaptation in different contexts for answering **RQ2**. We categorized the enactment approaches into 9 categories of addressed processing problems, 6 adaptation goals, 9 evaluation metrics and 12 evaluation parameters to obtain an overview of the adaptation focuses from different perspectives.

## Literatur

- [CJ09] Chakravarthy, S.; Jiang, Q.: Stream data processing: a quality of service perspective: modeling, scheduling, load shedding, and complex event processing. Springer Science & Business Media, 2009.
- [KI17] Kleppmann, M.: Designing Data-Intensive Applications: The Big Ideas Behind Reliable, Scalable, and Maintainable Systems. O'Reilly Media, Inc., 2017.
- [QES19] Qin, C.; Eichelberger, H.; Schmid, K.: Enactment of Adaptation in Data Stream Processing with Latency Implications—A Systematic Literature Review. Information and Software Technology 111/, S. 1–21, 2019, issn: 0950-5849, URL: <https://www.sciencedirect.com/science/article/abs/pii/S0950584919300539>.