Akshay Paranjape, M.Sc.

1.

Paranjape, Akshay, Praneeth Katta, and Markus Ohlenforst. "Automated Data Pre-processing for Machine Learning based Analyses." COLLA 2022, The Twelfth International Conference on Advanced Collaborative Networks, Systems and Applications, May 22-26, 2022, Venice, Italy. IARIA, 2022.

[Paranjape et al. Automated Data Pre-processing 2022 COLLA](https://www.thinkmind.org/library/COLLA/COLLA_2022/colla_2022_1_10_50012.html)

**Abstract:**

Data pre-processing is crucial for Machine learning (ML) analysis, as the quality of data can highly influence the model performance. In recent years, we have witnessed numerous literature for performance enhancement, such as AutoML libraries for tabular datasets, however, the field of data preprocessing hasn’t seen major advancement. AutoML libraries and baseline models like Random Forest are known for their easy-to-use implementation with data-cleaning and categorical encoding as the only required steps. In this paper, we investigate some advanced pre-processing steps such as feature engineering, feature selection, target discretization, and sampling for analyses on tabular datasets. Furthermore, we propose an automated pipeline for these advanced pre-processing steps, which are validated using Random Forest, as well as AutoML libraries. The proposed pre-processing pipeline can also be used for any ML-based algorithms and can be bundled into a Python package. The pipeline also includes a novel sampling method - “Bin-Based sampling” which can be used for general purpose data sampling. The validity of these pre-processing methods has been assessed on OpenML datasets using appropriate metrics such as KL-divergence, accuracy-score, and r2-score. Experimental results show significant performance improvement when modeling with baseline models such as Random Forest and marginal improvements when modeling with AutoML libraries.

2.

Büscher, Jan, Akshay Paranjape, Roman Möhle, Mikhail Polikarpov, Nils Plettenberg, Ronny Zwinkau, Jochen Deuse and Robert H. Schmitt "Bauteile ressourceneffizient reinigen mithilfe von KI." JOT – Journal für Oberflächentechnik, December 29, 2022. https://www.jot-oberflaeche.de/zeitschrift/heftarchiv/artikel/bauteile-ressourceneffizient-reinigen-mithilfe-von-ki-3305477.html.

[Büscher, Paranjape Journal für Oberflächentechnik](https://www.jot-oberflaeche.de/zeitschrift/heftarchiv/artikel/bauteile-ressourceneffizient-reinigen-mithilfe-von-ki-3305477.html)

**Abstract:**

Prozessparameter von Bauteilreinigungsanlagen werden häufig manuell eingestellt und beruhen auf über Jahre gesammeltem Expertenwissen. Dieses Wissen gilt es, so zu erfassen, dass Modelle für maschinelles Lernen beziehungsweise künstliche Intelligenz trainiert und angewendet werden können. Das ptimierungskriterium ist der Ressourcenverbrauch, der durch Eingangs- und Prozessparameter determiniert wird.

3.

Paranjape, Akshay, and Nils Plettenberg, Markus Ohlenforst and Robert H. Schmitt. "Reinforcement Learning for Quality-Oriented Production Process Parameter Optimization Based on Predictive Models." \*Advances in Transdisciplinary Engineering\* 23 (2023): 327-344. https://doi.org/10.3233/ATDE230059.

[Paranjape et al. Reinforcement Learning for Quality-Oriented Production Process Parameter Optimization Based on Predictive Models](https://ebooks.iospress.nl/doi/10.3233/ATDE230059)

**Abstract:**

Production of low-quality or faulty products is costly for manufacturing companies since it wastes a lot of resources, human effort, and time. Avoiding such waste requires the correct set of process control parameters, which depends on the dynamic situation in the production processes. Research so far mainly focused on optimizing specific processes using traditional optimization algorithms, mainly evolutionary algorithms. To develop a framework that enables real-time optimization based on a predictive model for an arbitrary production process, this paper explores the application of reinforcement learning (RL) in the field of process parameter optimization. Inspired by the literature review on both production process parameter optimization, and RL, a model based on maximum a posteriori policy optimization that can handle both numerical and categorical parameters is proposed. A validation study conducted on data sets from production fields compares the trained model to state–of–the–art traditional optimization algorithms and shows that RL can find optima of similar quality while requiring significantly less time.

4.

Akshay Paranjape, Ugur Küpper, Daniel Schulze Brock, Robert H. Schmitt, Markus Ohlenforst and Martin Peterek. Real-time Quality Monitoring of Wire EDM Process Using Machine Learning, 18th CIRP Conference on Intelligent Computation in Manufacturing Engineering, 10-12 July, Naples, Italy. (not yet online)

[Paranjape et al. CIRP ICME 2024](https://iconproai-my.sharepoint.com/:b:/g/personal/akshay_paranjape_iconpro_com/EdhT29VxznFAvwQvSxdOv60BJpd8o2tGKhso3KtEqjQnOw?e=ADWzNs)

**Abstract:**

Traditional quality assessment in EDM involves labor-intensive manual evaluation of geometric deviations. Anticipating curvatures post-main cut allows compensation through trim cut adaptation, streamlining the process. This paper presents a novel approach for automating and realtime quality monitoring of Wire EDM processes through the integration of machine learning models trained on historical process and quality data. The effectiveness of this method is validated on industrial Wire EDM machine along with feature importance analysis to provide insights into the underlying patterns captured. Testing on industrial unseen data demonstrates a mean absolute error of approx. 1 µm for geometric curvature deviation in the Wire EDM process.

5.

Paranjape, Akshay and Nils Plettenberg. Quality-oriented Production process parameter optimization based on Predictive Model. 3DMC Nov 2023, Aachen, Germany.

[3DMC\_Paranjape Nov 2022](https://iconproai-my.sharepoint.com/:b:/g/personal/akshay_paranjape_iconpro_com/EdZWnTmkevVPgRMbuOjC3kMBH9IHPfkbeNUZ2A5TwVwlIA?e=cdGmwS)

6.

J. Neuß, A. Paranjape, J. Kelbassa, N. Quader, M. Peterek, P. Abels. Machine Learning for wire-based additive manufacturing, PMD Vollversammlung Sept 2024, Berlin, Germany.

[Poster\_PMD\_Vollversammlung\_2024\_Machine\_Learning](https://iconproai-my.sharepoint.com/:b:/g/personal/akshay_paranjape_iconpro_com/EW5K3T-31WZHr2aGjPEHjSsBQYxDP1_eYgVgRaqbzT7oIw?e=FLTNzC)

Submitted & available pre-prints

1.

Paranjape, Akshay, Martin Peterek, and Robert H. Schmitt. Manufacturing process parameter optimization: Comprehensive review and survey. (Planned for Management and Production Engineering Review Journal, end of 2024)

**Abstract:**

Manufacturing industries pose major challenges in reducing scrap produced during manufacturing processes. Any measurable element of input during the manufacturing process, such as temperature, raw material, wire feed rate, etc., or any transformation activity in a process that affects the output of the process can be referred to as a process parameter. Optimizing process parameters through various techniques can help reduce the scrap rate and improve the quality of the parts in production. The research addresses and summarizes the available literature on manufacturing process optimization, mainly by optimizing process parameters. The survey addresses techniques used by major manufacturing processes like shaping, forming, machining, joining, and finishing process. The retrospective of the survey highlights the need for further research in inline optimization of process parameters for dynamic changing situations. The paper concludes by inviting further academic and industrial research with advanced machine learning methods for optimizing manufacturing process parameters.

Preprint

2.

Akshay Paranjape, Nahid Quader, Benjamin Berkels, Robert H. Schmitt, Lars Uhlmann, Thomas Bergs. Reinforcement Learning controller for multi-objective process parameter optimization of pinion manufacturing process. (Planned for Journal publication: International Journal of Computer Aided Manufacturing, end of 2024)

**Abstract:**

The optimization of manufacturing processes to minimize scrap or enhance process stability presents significant challenges. As the number of objectives increases, the complexity of the optimization problem escalates accordingly. Additionally, when optimization results are required in real-time within production processes, there is a further challenge in generating optimal parameter solutions within a specified time frame. In this study, we propose a reinforcement learning-based multi-objective framework for optimizing manufacturing process parameters, demonstrated with a case study on a pinion manufacturing system. The model employs a Multi-Objective MPO (MO-MPO) algorithm to design the reinforcement learning controller. A simulation of the pinion manufacturing process is developed using Simufact, and the controller's results are validated both through a hold-out test set and by simulating the actual process. The results align well with industrial requirements, and the proposed method is further validated for Pareto-optimal solutions using half-plane analysis.