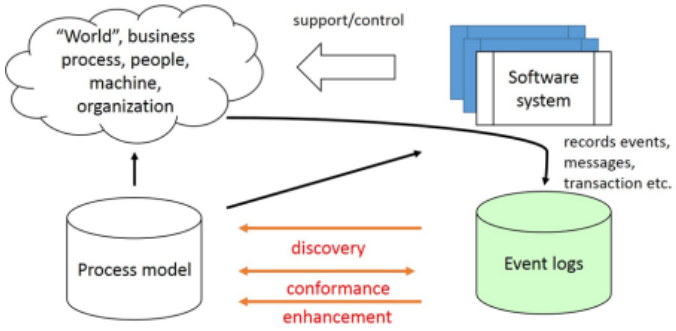
Business Process Analysis in Manufacturing & Logistics

LogDynamics
International Graduate School

Enterprises place a high emphasis on business processes as they are considered a core competency in product development and value-added tasks. However, enterprises in manufacturing and logistics systems struggle to improve and manage their business processes effectively as a result of the high degree of complexity and dynamics. In order to improve business processes in a complex and dynamic environment, intensive knowledge of business processes is vital.

A promising way of acquiring process knowledge is process mining. It can be used to discover, monitor, and improve business processes. The figure below depicts the three main types of process mining: discovery, conformance, and enhancement. It is based upon data mining. While classical data mining is data-centric, process mining is process-centric. It has proven feasible and effective in the area of business process improvement.



The three main types of process mining extracted
[van der Aalst, Wil, et al. 2008]

Process mining is the analysis of the event logs in order to gain insight into existing business processes. Enterprises' tasks are supported and controlled by software systems. These systems generate and store transactions or activities in the form of event logs. Event logs are files and databases containing event-based data collected during the regular operations, such as manufacturing and transportation schedules, delivery receipts, and repair logs. The process knowledge can be extracted from a large number of event logs collected during the normal operations of manufacturing and logistics processes. Process mining can generally be classified into 3 three types: (1) discovery, (2) conformance, and (3) enactment.

Process discovery is the main objective of process mining based on event logs, which aims to find the actual processes and process variants. Process conformance intends to conform the designed process model to the actual process. It can be extended to utilize in the cases of fraud detection or deviations. The process enhancement aims to extend or improve the existing business process models using information recorded in event logs. For example, process enhancement aims to modify the process model to better reflect the real process. The output of process mining are various types of process models, which are then used as input for improving business processes.

However, process mining relies on sufficient event logs for analysis. Often, these event logs are unstructured, unreliable, lossy and noisy. Moreover, complex business processes are difficult to model. They cause spaghetti-like process models that are hard to comprehend. Furthermore, the huge amount of data requires automatic and intelligent data analysis methodologies in order for the valuable knowledge to be discovered. Therefore, process mining needs additional steps to prepare data for an analysis.

Moreover, process mining can go beyond analyzing historical data. In a dynamic environment, business processes are still accompanied by context information. In order to the process mining technique, relevant context information must be considered in order to enhance the mined process results. Analyses of contextual information assist in the process of indicating the process variants and the need for process changing as well as facilitating learning from the past to support decision-making.

Wacharawan Intayoad
M.Sc

Information Systems

Chiang Rai, Thailand
int@biba.uni-bremen.de

International Graduate School for Dynamics in Logistics
Contact: Dr.-Ing. Ingrid Rügge

Universität Bremen
Hochschulring 20
28359 Bremen, Germany

www.logistics-gs.uni-bremen.de
info@IGS.Log*Dynamics*.de

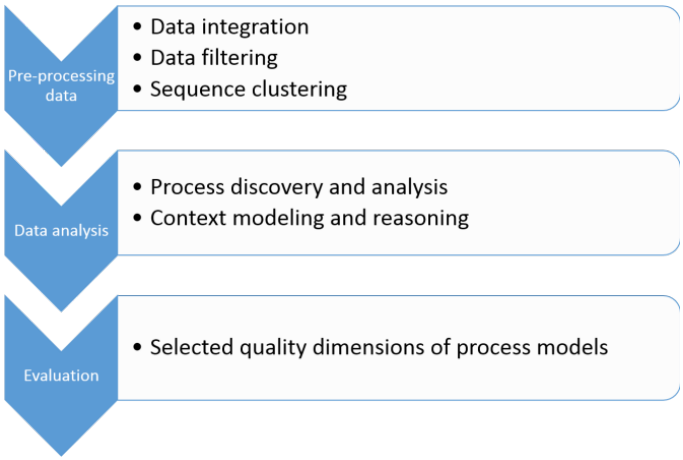
University of Bremen

Therefore, our objective is to overcome the challenges of process mining when analyzing processes in complex and dynamic environments as well as from less structured event data. We propose, as a new methodology, to develop and evaluate an automatic business process discovery system in manufacturing and logistics based on large-scale transaction data and context information. The following sub-research questions have to be addressed:

- What is a suitable methodology for automatic pre-processing of large and heterogeneous data sources in process mining?
- What is a suitable methodology for process discovery when dealing with complex business processes and semi-structured/unstructured event data?
- How to exploit the relationship between business processes and context information?
- Which type of available context information is best suited for business process discovery?

Research Methodology

The research experiments are conducted with real-world data from manufacturing and logistics companies. The methodology of the research consists of three steps:



Data pre-processing: First, some data-related items and features can be eliminated from the event data since datasets may contain irrelevant attributes. Then, datasets from different sources will be integrated into the same format and same scheme to fit into the process analysis. Afterwards we can apply data filtering to eliminate the outlier data. The second task is grouping similar process instances with the aim of reducing the complexity of the large volume of data. This task deploys a Markov chain as a method clustering technique. In addition, since the Markov chains are unknown in the beginning, Expectation-Maximization (EM) is applied to generate the transition matrix for each cluster.

Data Analysis and Discovery: This phase consists of two subtasks. The first one, namely process discovery, identifies general process patterns and process variants. Heuristic mining and inductive mining techniques are deployed to discover the behavior of the actual processes. The second task focuses on context modeling and reasoning in order to analyze the relationship between context information and particular processes. We focus on the methodology to capture the relevant context information that affects the business process performance. We use process lead-time as Key Performance Indicators. We select two types of contextual information to analyze and infer the influence to process lead-time: (1) the number of process activities/events, which compete for the same resources, and (2) the process lead-time of the previous order whether it was delayed. These two contexts are derived from real event logs from three different companies. Naïve Bayesian, arithmetic mean and standard deviation are applied for context reasoning.

Evaluation: the discovered process models, which include the context information, are evaluated. The goal of process mining is to provide accurate discovered models. Therefore, this research uses the quality dimensions that have been widely used in process mining, including replay fitness and precision.

Expected Outcome

Our proposed method is useful for enhancing the result of the current process mining approach when dealing with complex and less-structured data. Furthermore, the proposed system also exploits the relevant context information, which affects the business process behavior. The set of discovered knowledge is documented and utilized for domain experts to improve business process performance as well as to support decision-making.