Document 1 - Using Process Mining to Bridge the Gap

In the era of exponential growth in digitized information, the systematic collection of business-related events has become a transformative capability. This phenomenon falls under the umbrella term of Business Intelligence (BI), encompassing an array of tools and techniques designed to leverage event data for informed decision-making. Within this BI landscape, various three-letter acronyms, such as Business Activity Monitoring (BAM), Corporate Performance Management (CPM), Continuous Process Improvement (CPI), and Business Process Intelligence (BPI), denote tools ranging from simple reporting to sophisticated dashboard applications.

Despite the proliferation of BI tools, only a handful possess robust data mining capabilities, and those that do often lack a process-centric focus. Emphasizing data and localized decision-making, these tools fall short of addressing end-to-end processes. In contrast, Business Process Management (BPM) techniques and tools revolve around process models, gaining traction as organizations increasingly rely on BPM systems to streamline operational processes. However, a significant drawback emerges as these process models frequently remain detached from actual event data, rendering analysis results unreliable due to their reliance on an idealized model rather than observed facts.

Enter process mining, seeking to bridge the gap between BI and BPM by combining process models with event data. The foundational element of process mining is an event log, where each event pertains to a specific activity within a well-defined process step and is linked to a particular case or process instance. These events, chronologically ordered, encapsulate a single run of the process. Event logs may include additional information such as the executing resource (person or device), timestamps, and other data attributes, enhancing the depth of analysis.

Typically, process mining entails three distinct types: (a) process discovery, (b) conformance checking, and (c) model enhancement. Process discovery techniques derive a model from an event log without relying on supplementary information, resulting in an initial process model. Conformance checking techniques then compare observed behavior (event logs) with modeled behavior, pinpointing deviations and facilitating diagnostic insights. Subsequent to conformance checking, the model and log alignment occurs, leveraging information from the log to enhance the model. This enhancement may involve repairs or extensions, incorporating perspectives like time or resources. For instance, timestamps from the event log can furnish timing information, culminating in an augmented model poised for decision support (W. van der Aalst, Process Mining: Discovery, Conformance and Enhancement of Business Processes, Springer-Verlag, 2011).

In the realm of contemporary organizational management, the utilization of process mining emerges as a pivotal tool for handling intricate operational processes. The exponential growth of event data presents a challenge, necessitating a meticulous alignment of processes and information to adhere to compliance, enhance efficiency, and augment customer service. The application of process mining techniques becomes imperative in realizing such objectives.

The manifesto delineates the principles and challenges inherent in process mining, portraying it as a novel and exhilarating technology. The overarching objective is to furnish organizations with a paradigm akin to "Google Maps functionality" for their operational business processes. This envisages the creation and maintenance of up-to-date process maps tailored to specific use cases, allowing seamless zooming capabilities. Similar to the dynamic nature of Google Maps, less critical activities and pathways should either disappear or amalgamate into aggregate nodes when zooming out. Moreover, the integration of real-time information onto these process maps enables the visualization of "traffic jams" within processes, facilitating the identification of delayed cases and proposing alternative routes.

In stark contrast to conventional approaches, the distinctive feature of process mining lies in its departure from constructing a singular static model. Instead, it enables the dynamic generation of process maps based on the most recent data, tailored to address specific inquiries. This adaptability positions process mining as a dynamic and responsive solution in the ever-evolving landscape of organizational processes.

Document 2 - Business Process Analysis

In the realm of healthcare organizations, conducting business process analysis proves to be an intricate endeavor, primarily attributable to the highly dynamic, complex, ad hoc, and multi-disciplinary nature inherent in healthcare processes. Recognizing the potential of process mining as a valuable approach to gaining deeper insights into these intricate processes through the analysis of event data recorded in healthcare information systems, this dissertation delves into the challenges faced by conventional process mining techniques in effectively capturing the nuanced and ad hoc characteristics prevalent in clinical workflows. The research introduces a novel methodology designed to enhance the application of process mining techniques, facilitating the identification of regular behavior, process variants, and exceptional medical cases within healthcare processes. To illustrate the practicality and efficacy of the proposed methodology, a comprehensive case study was conducted at a hospital emergency service. The methodology was implemented in a dedicated tool that seamlessly integrates the core stages of process analysis, tailored specifically for the nuances of the case study. Importantly, the adaptability of this methodology is emphasized, indicating its potential applicability in diverse healthcare environments beyond the confines of the specific case study. This dissertation contributes to advancing the understanding and application of process mining techniques in healthcare, offering a nuanced perspective on addressing the complexities associated with business process analysis in this domain.

This dissertation introduces a novel methodology tailored for the application of process mining techniques in healthcare settings, facilitating the identification of regular behavior, process variants, and exceptional medical cases. The proposed approach is exemplified through a detailed case study conducted within a hospital emergency service. To operationalize this methodology, a specialized tool has been developed, seamlessly integrating the essential stages of process analysis. Although the tool is designed for the specific nuances of the case study, its adaptable nature renders it applicable to diverse healthcare environments, thereby enhancing the overall understanding and management of complex healthcare processes.

In the domain of healthcare, process mining emerges as a valuable tool, illuminating the intricate pathways of healthcare processes, evaluating their performance, and assessing adherence to institutional or clinical guidelines. Notably, sequence clustering analysis has proven instrumental in navigating the extensive diversity of log traces. This methodology adeptly discerns and analyzes a spectrum of behavioral patterns, encompassing regular and infrequent behaviors along with their variants. The revelations facilitated by this approach extend beyond mere process insights, exposing instances of clinical malpractice, potential resource wastage, performance bottlenecks, violations of service level agreements, and potential breaches of internal practices.

Interestingly, a disjunction emerges between the subjective perceptions of professionals and the objective results unveiled through process mining. This dissonance underscores the need for objective data-driven insights to augment the decision-making process. The developed

process mining framework has demonstrated immense value for the hospital, despite resource constraints. It empowers the institution to exert control over emergency processes using empirical data, thereby mitigating risks and enhancing operational efficiency. A notable achievement is the substantial reduction in the cost of analysis, rendering it feasible for the hospital to conduct assessments as needed. The scalability of the solution is commendable, allowing for the analysis of any emergency process contingent upon patient diagnosis—a feat unattainable with traditional Business Process Analysis (BPA). Furthermore, extending the solution to other departments merely requires acquiring additional data from the hospital system.

However, a critical imperative for enhancement lies in the usability of process mining and the interpretability of results for non-experts. While both IT and non-IT professionals express interest in leveraging process mining, the perceived technical complexity poses a barrier. To attain widespread adoption within the organization, improvements in usability must reach a threshold where professionals can undergo training without necessitating a profound technical understanding. Failure to achieve this could result in the unwarranted reliance on specialists, a prospect incongruent with the hospital's economic landscape and organizational culture. Addressing this challenge is paramount to unlocking the full potential of process mining within the healthcare domain.

Document 3 - Process Mining Organization Modeling and Health

The Process Mining Organization (PMO) represents a pioneering approach grounded in artificial intelligence (AI) decision-making, specifically tailored for the strategic design of healthcare processes within human resource (HR) organizations. This dissertation delves into the intricacies of PMO and its application, emphasizing its capacity to revolutionize HR management through AI-driven decision-making. The research introduces exemplary instances of PMO-based Business Process Modeling and Notation (BPMN) workflows, underscoring their progressive impact on HR functions and risk mitigation within healthcare contexts.

The primary focus lies in presenting diverse "TO BE" process pipelines, illustrating the enhancement of organizational healthcare frameworks through the integration of digital technologies and telemedicine. The study furnishes crucial insights into formulating HR management guidelines that substantiate the design of PMO. These BPMN workflows are meticulously crafted, emerging from consultative interventions in healthcare institutions. The preliminary analysis involves mapping "AS IS" processes, thereby pinpointing bottlenecks and HR-related needs in organizational structures.

A pivotal component of this research involves the utilization of a pilot experimental dataset to demonstrate the application of AI algorithms. This dataset serves as a practical showcase for implementing corrective actions within organizations, guided by the insights derived from AI-driven decision-making processes. The crux of the paper is a thorough discussion of validated BPMN models specifically tailored for managing HR functions within the healthcare sector.

Methodologically, the study employs the BPMN approach to deploy and streamline human resource organizational processes. The obtained results showcase the efficacy of AI data-driven workflows when applied to healthcare settings, and the paper exemplifies instances of AI fuzzy c-means outputs, offering nuanced solutions to organizational challenges. In essence, this dissertation contributes significantly to the discourse on AI-powered process mining in healthcare, shedding light on its potential to reshape HR management practices and enhance organizational efficiency.

In this article, the focus is on providing valuable insights for the design of optimized organizational processes within healthcare settings. The discussion revolves around various theoretical workflows, serving as foundational "templates" that can be adapted for more intricate workflows or tailored to specific case studies. The primary objective is to enhance the alignment between digital technologies and artificial intelligence (AI) in healthcare organizational models, with a specific emphasis on their application in risk assessment, human resources (HR) management, and care optimization.

The paper also contributes to understanding a novel Project Management Office (PMO) approach, supplanting the traditional Lean Six Sigma (LSS) methodology, and advancing the

customization of healthcare processes. The "TO BE" workflows proposed in the paper are developed subsequent to identifying bottlenecks in healthcare organizations through the mapping of the existing "AS IS" status. The initial data processing approach underscores the potential utilization of AI algorithms for guiding processes, exemplifying the application of an unsupervised AI algorithm in healthcare corrective actions (see Appendix A).

Validation of the proposed "TO BE" processes will be contingent upon Key Performance Indicator (KPI) evaluations concerning HR efficiency, resource management efficiency, and health risk reduction. Additionally, the paper introduces an audit framework (refer to Appendix B), serving as a benchmark (audit form) for AI-based KPI evaluations pertaining to material management, HR corrective actions, and planning strategies. This framework aims to monitor the impact of the envisioned processes on healthcare organizations. A minimum of two years of data collection is deemed necessary for an initial substantial evaluation of the optimized organizational processes. Nevertheless, a preference is expressed for ongoing process control through different milestones (checkpoints) contingent upon the complexity of the implemented process.

Document 4 - A Graph Based Approach to Interpreting Recurrent Neural Networks in Process Mining

In contemporary organizational contexts, the utilization of process mining stands as a prevalent strategy for scrutinizing business processes, effecting audits, and enhancing services and customer relations. The continuous generation of process execution logs across diverse information systems serves as a valuable repository, enabling the extraction of crucial insights into business operations. Traditional process mining techniques, such as Petri nets and the Business Process Model and Notation (BPMN), have historically been employed for this purpose. However, recent advancements, particularly in the realm of deep learning, specifically Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks, have demonstrated superior performance in terms of accuracy and generalization when predicting subsequent events within business processes.

Despite their enhanced predictive capabilities, deep learning-based methods, in contrast to conventional network-centric process mining approaches, lack transparency in explaining the rationale behind their predictions. This scholarly investigation proposes an innovative fusion of the merits of visually explainable graph-based methods with the advanced accuracy of deep learning techniques. The suggested approach entails the initial application of an LSTM model to establish probabilities for the occurrence of each known event in the subsequent stages of the process. Subsequently, these probabilities are employed to construct a visually interpretable process model graph, elucidating the decision-making process inherent in the LSTM model. The granularity of this graph can be flexibly adjusted using a probability threshold, accommodating diverse process mining objectives, including business process discovery and conformance checking.

This novel approach strives to reconcile the trade-off between accuracy and explainability in process mining. By seamlessly integrating the predictive power of deep learning with the transparency of graph-based visualization, the proposed methodology not only outperforms existing LSTM-based process mining methods in terms of accuracy but also provides a comprehensible representation of the underlying decision logic. The efficacy of this approach is substantiated through empirical validation using real-world event logs, thus affirming its potential to advance the field of process mining with tangible benefits in both predictive precision and interpretability.

In conclusion, this dissertation introduces an innovative approach to process mining that integrates graph-based methods for process discovery with deep learning techniques for event sequence prediction. The proposed methodology comprises two key stages: first, the development of a robust Long Short-Term Memory (LSTM) model to predict event sequences in business processes based on event logs, and second, the creation of a directly follows graph elucidating the decision-making process of the LSTM model during event sequence predictions. Two distinct model architectures, utilizing unidirectional and bidirectional

LSTMs, were formulated, both surpassing the performance of contemporary LSTM models in process mining, as demonstrated on two real-life event logs. Additionally, the study explored the advantages and limitations of the proposed LSTM models by employing three additional real-life logs. The bidirectional LSTM model exhibited slightly superior results on more complex or larger logs, albeit with an increased training time. Visualization of the generated graphs effectively illustrated the interpretability of LSTM models, while a proposed method to assess graph similarity validated the models' generalization capabilities.

A notable strength of the proposed approach lies in its model-agnostic nature, where the graph-generation component operates independently of the predictive modeling section. This implies that alternative models can seamlessly replace the LSTM. Future endeavors will explore the adaptability of the approach by experimenting with other deep learning architectures, such as encoder-decoder networks. Additionally, the dissertation outlines plans to assess the proposed approach's viability as a process discovery method, evaluating generated graphs using established process mining metrics, including model fitness, precision, generalizing ability, and complexity. This holistic approach not only enhances our understanding of LSTM models' performance but also provides a foundation for diverse process mining tasks, encompassing process discovery, conformance checking, and the investigation of non-compliance cases.