MINI PROJECT REPORT

Predictive Process Mining in BPM using Attention-based LSTM Networks

Submitted in partial fulfillment of the requirements for the degree of

Master of Technology in Data Science

by

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January 2026

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Chapter 1

Introduction

1.1 Background

Business Process Management (BPM) tools such as PEGA and UiPath have revolutionized enterprise operations through Robotic Process Automation (RPA). However, these systems primarily operate on deterministic, static rules. While they excel at execution, they lack foresight. When a process fails or encounters a bottleneck, the intervention is inherently reactive.

1.2 Problem Statement

In traditional BPM environments, historical execution data is often underutilized. Current systems rely on simple heuristic averages to estimate completion times, which ignores the intricate context of individual cases. There is a critical need for a system that can predict the *"Next Best Action"* or *"Remaining Time-to-Completion"* proactively.

Chapter 2

Literature Survey

2.1 Existing Solutions

The foundational work by **Tax et al. (2017)** titled *"Predictive Business Process Monitoring with LSTM Neural Networks"* demonstrated that Long Short-Term Memory (LSTM) networks could outperform traditional Markov models by capturing long-range dependencies in event logs.

2.2 Drawbacks of Current Systems

- **Context Insensitivity:** Most industry-standard tools ignore the specific sequence of events that led to the current state.
- **Lack of Explainability:** Standard LSTMs act as black boxes, offering a prediction without highlighting which previous activity caused the predicted delay.
- **Reactive Bottleneck Management:** Systems report bottlenecks only after they have occurred.

Chapter 3

Proposed Methodology

3.1 Solution Overview

This project proposes an **Attention-augmented LSTM Architecture**. By integrating an Attention Mechanism, the model not only predicts the next step but also assigns "weights" to previous activities. This allows the system to identify which specific step in the workflow (e.g., "Manual Approval" or "Verification") is the statistical driver of a bottleneck.

3.2 Modification and Improvement

The key modification involves the transition from a standard LSTM to an **Attentive-LSTM**.

- **Attention Integration:** The model calculates an attention score for every event in the trace.
- **Dynamic Resource Allocation:** Based on the "Next Best Action" prediction, RPA bots can be pre-allocated to high-probability paths.

3.3 Technical Workflow

1. **Data Ingestion:** Extraction of XES/CSV event logs using `Pm4Py`.
2. **Pre-processing:** One-hot encoding of activity labels and normalization of timestamps using `Pandas`.
3. **Modeling:** Building the LSTM layers followed by an Attention layer using `PyTorch`.

4. **Evaluation:** Measuring performance using Mean Absolute Error (MAE) for time prediction and Accuracy for activity prediction.

Chapter 4

Implementation Details

4.1 Software Stack

- **Language:** Python 3.11
- **Process Mining:** `Pm4Py` (for handling event logs).
- **Deep Learning:** `PyTorch` (for Neural Network implementation).
- **Data Processing:** `NumPy` and `Pandas`.

4.2 Addressing Existing Drawbacks

The proposed solution addresses the drawback of ”Context Ignorance” by utilizing the hidden states of the LSTM, while the Attention Mechanism solves the ”Lack of Explainability” by providing a visual heatmap of activity importance.

Chapter 5

Conclusion

By shifting BPM from a reactive to a predictive paradigm, enterprises can significantly reduce operational costs. The integration of Data Science tools with professional automation platforms like UiPath and PEGA represents the next frontier in Intelligent Process Automation (IPA).