# Comparative Analysis of Discovered Models for the Robotic Arm (RA) Component

Experimental Report

December 22, 2025

## 1 Introduction

This report presents the Petri net models discovered for the Robotic Arm (RA) component of the Automated Manufacturing System. The models were generated using various standard Process Mining algorithms available in the ProM framework.

The input event log, $T_{RA}$, contains traces capturing the identification of parts (events $i$ or $j$), the grabbing action ($k$), and the routing to the subsequent station ($l$ or $m$). The ground truth behavior requires a *non-free choice* routing:

- Sequence $i \to k \to l$ (Type 1 part $\to$ Paint)

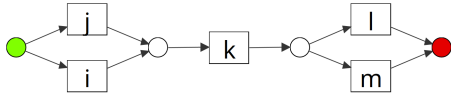- Sequence $j \to k \to m$ (Type 2 part $\to$ Mill)

The following figures illustrate how each algorithm generalized this behavior.
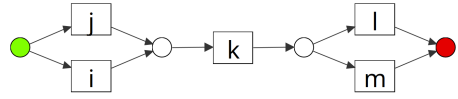
## 2 Discovered Models

### 2.1 Alpha Miner Family

Figure 1 displays the results from the Alpha Miner variants.
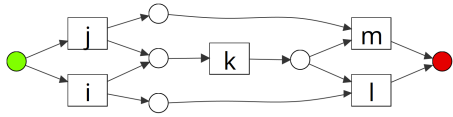
**Observation:** While the standard Alpha, Alpha+, and Alpha\$ miners produced structures with *free choice* after event $k$ (losing the routing context), the **Alpha++ Miner** (Figure 1c) successfully identified the non-local dependencies. It introduced additional places connecting $j \to m$ and $i \to l$, thereby restricting the choice after $k$ and correctly modeling the non-free choice behavior required by the robotic arm.
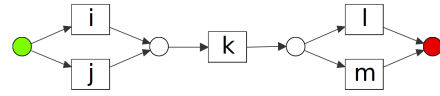
(a) Alpha Miner (Free Choice)



(b) Alpha+ Miner (Free Choice)



(c) Alpha++ Miner (Correct Non-Free Choice)



(d) Alpha$ Miner (Free Choice)

Figure 1: Models discovered by the Alpha Miner family. Alpha++ distinguishes itself by capturing the routing dependency.

## 2.2 Heuristic and Inductive Approaches

Figure 2 groups the algorithms that rely on dependency graphs (Heuristics Miner, Fodina) and process trees (Inductive Miner). Fodina is specifically designed as a robust heuristic miner.
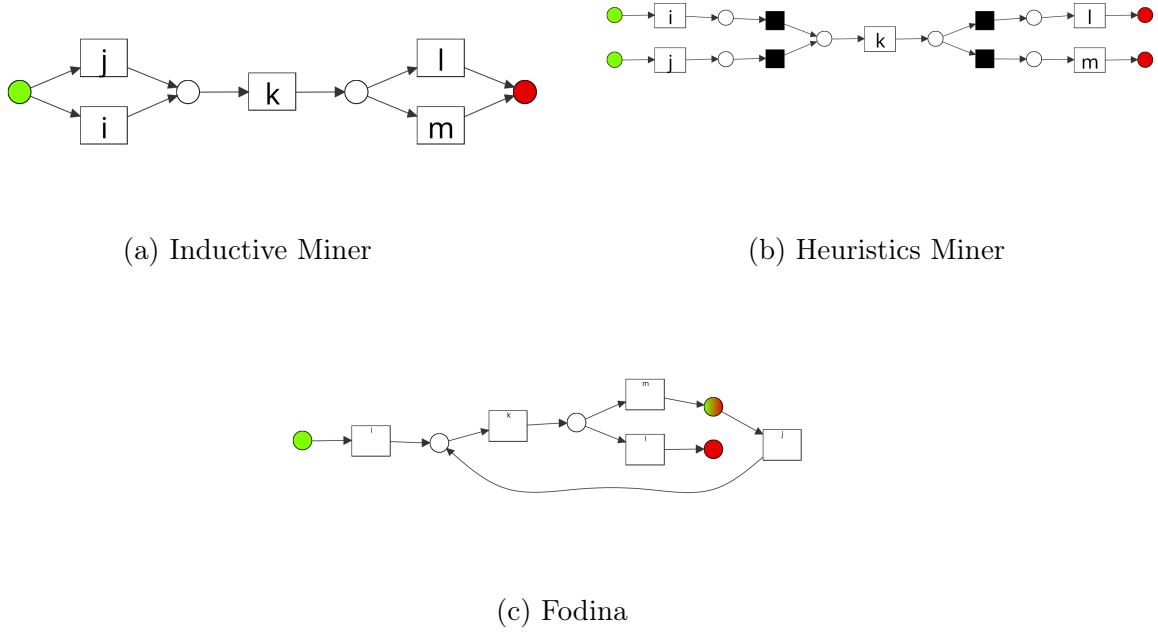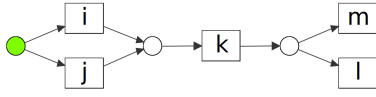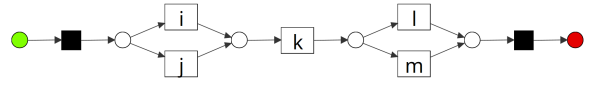


(a) Inductive Miner



(b) Heuristics Miner



(c) Fodina

Figure 2: Models discovered by Inductive, Heuristics, and Fodina algorithms.

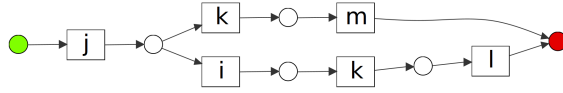## 2.3 Optimization-based Approaches (ILP & Evolutionary)

Figure 3 presents models discovered using mathematical optimization (ILP variants) and genetic algorithms (ETMd).

(a) ILP Miner



(b) Hybrid ILP Miner



(c) Evolutionary Tree Miner (ETMd)

Figure 3: Models discovered by ILP variants and Evolutionary Tree Miner.