

AI Optimization Model for Heat Treatment Scheduling

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Problem Statement

The current heat treatment scheduling process is inefficient due to challenges in managing furnace capacity, energy consumption, and processing time. This leads to increased costs, inconsistent product quality, and environmental impact. An AI-driven optimization model can address these issues by improving scheduling efficiency and resource utilization.

Constraints

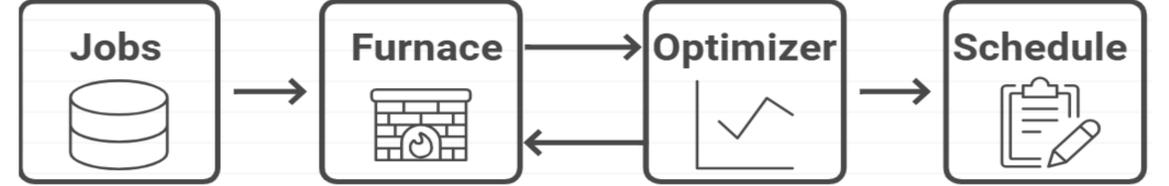
- Data Availability and Quality 
- Computational Resources 
- Industry Standards Compliance 

Specifications

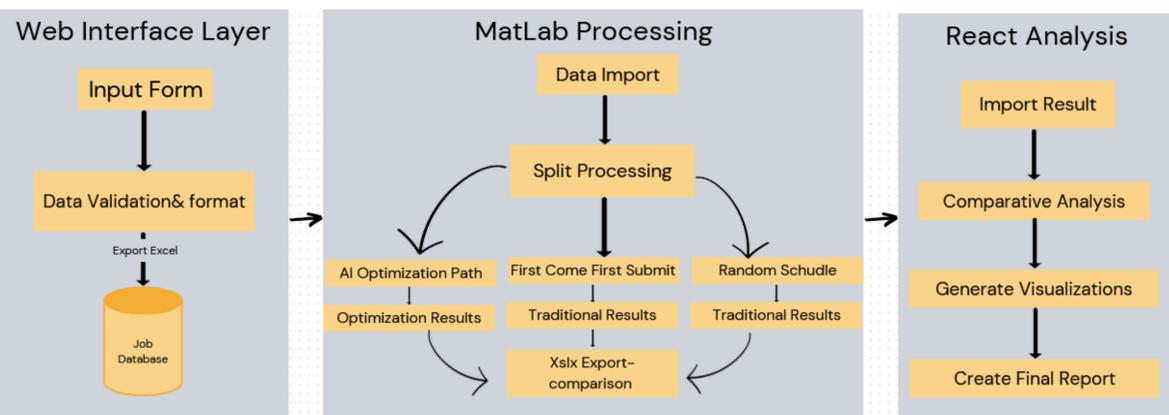
-  Fuel Consumption Decrease: 3-15%
-  Processing Time Reduction: 3-10%

Prototype Design

Data Flow



Integration Framework



Our prototype consists of three modules that aim to shorten or optimize the heat treatment processes with the help of custom-made algorithms through AI. The system contrasts traditional and optimized methods and analysis of improvement efficiency and resource usage.

The modules linked through manual data transfer protocols:

- Web → MATLAB: Structured Excel files
- MATLAB → Python: Standardized Excel format
- React → User: Detailed comparative reports

Verification

Interface

#	Job Name	Temperature (°C)	Time (minutes)	Actions
1	4140	845	60	
2	4340	870	45	
3	8620	900	30	
4	4320	925	40	
5	5160	880	35	
6	4150	860	50	
7	4130	840	55	
8	8640	855	45	
9	8740	875	40	
10	5140	850	50	

Performance Analysis

Processing Time Comparison

FCFS	621.96 min
Random	651.24 min
PSO	595.00 min

Fuel Consumption Comparison

FCFS	952.14 units
Random	958.21 units
PSO	895.89 units

Detailed Analysis Report

FCFS Results
 Time: 621.96 minutes
 Fuel: 952.14 units
 Schedule: 1 → 2 → 3 → 4 → 5 → 6 → 7 → 8 → 9 → 10

Random Results
 Time: 651.24 minutes
 Fuel: 958.21 units
 Schedule: 6 → 3 → 7 → 8 → 5 → 1 → 2 → 4 → 9 → 10

PSO Results
 Time: 595.00 minutes
 Fuel: 895.89 units
 Schedule: 8 → 7 → 2 → 6 → 10 → 1 → 5 → 9 → 3 → 4

PSO vs FCFS
 Time reduction: 4.3%
 Fuel reduction: 5.9%

PSO vs Random
 Time reduction: 8.6%
 Fuel reduction: 6.5%