Operations Research
Production Planning Optimization

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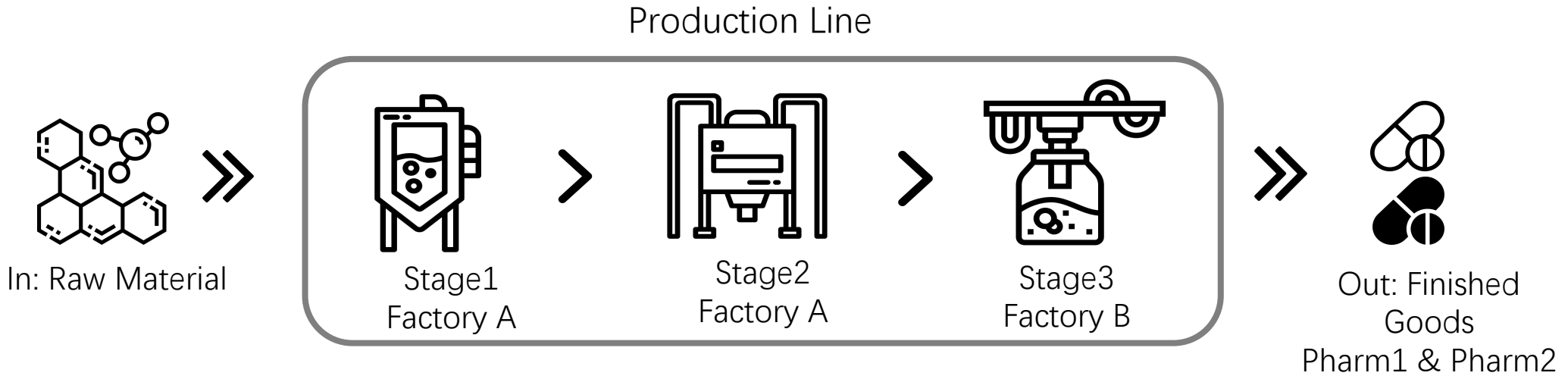
OUTLINE

1. Context
2. Problem
3. Approach
4. Result

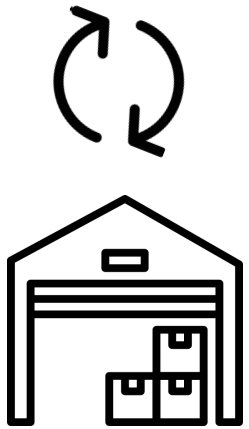
1. Context

1. Context



Basic Information

- 2 Factories
  - Factory A
  - Factory B
- 2 Finished Goods
- 3 Production Stages

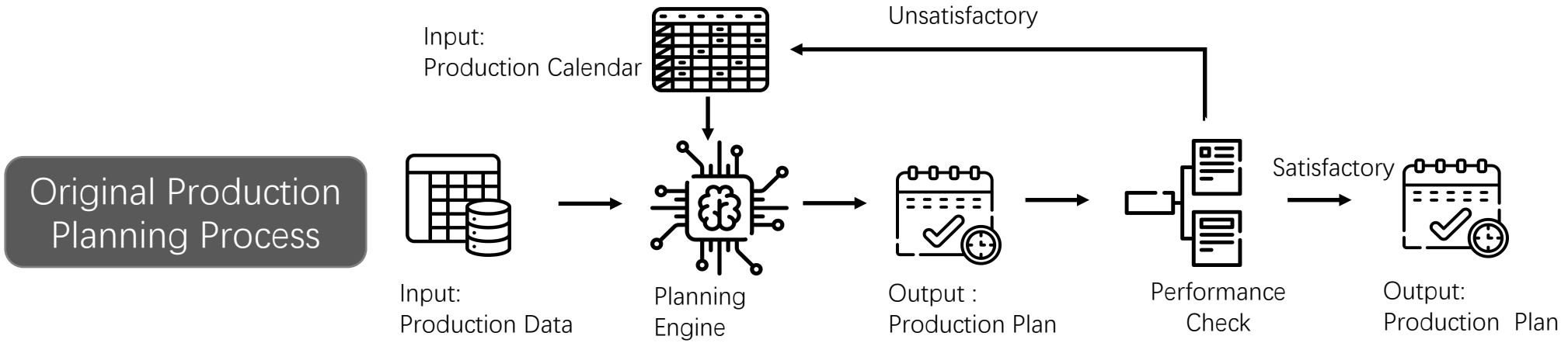


Production Plan

- Avoid Backorders
- Reduce Inventory Level
- Keep Enough Inventory

2. Problem

2. Problem



Planning Steps

1. Make Production Calendar
2. Input Calendar & Data to Engine
3. Check Performance of Plan
4. Satisfactory, Finished;
   Unsatisfactory, Go back to Step1

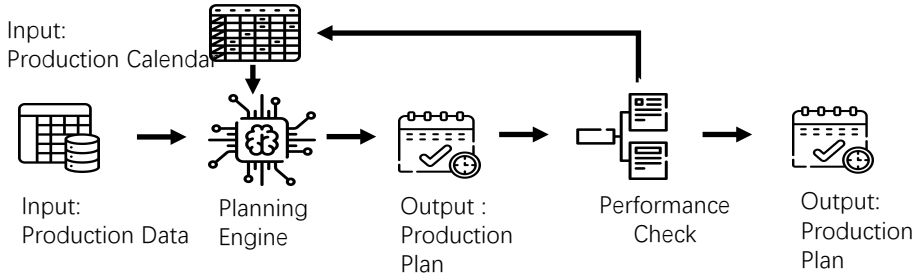
Two Shortcomings

Time Consuming
- Make Production Calendar Manually
- Take Several Iterations

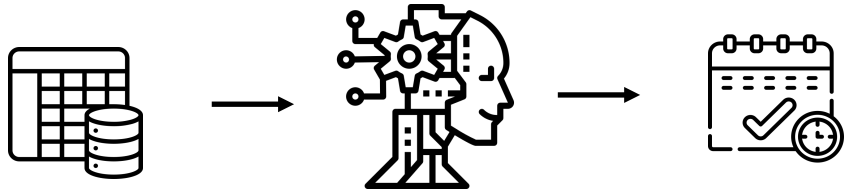
Local Optimum
- Space for Improvement

2. Problem

Original Production Planning Process



New Production Planning Process



Input:
Production Data

New
Planning
Engine

Output:
Production Plan

Planning Steps

1. Input Production Data
2. Output Optimal Production Plan

Problem Statement

New Planning Engine
- Streamline the Planning Process
- Find the Optimal Production Plan

3. Approach

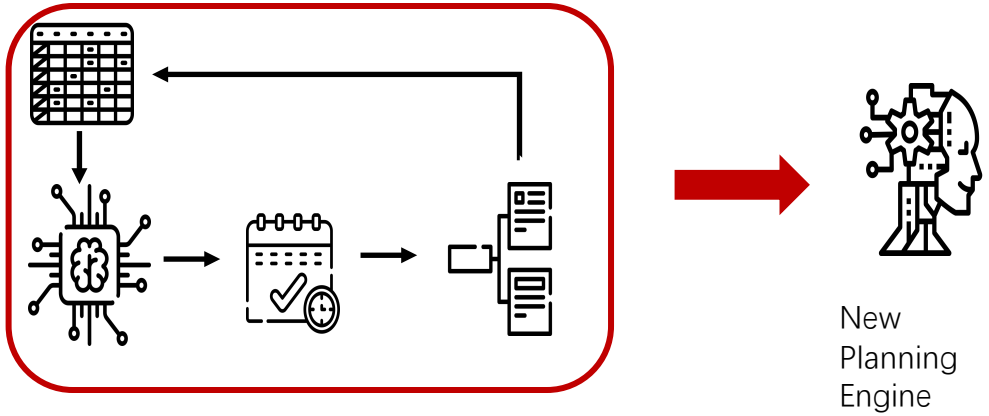
3. Approach

Modeling the Whole Planning Process

- Develop Algorithm to Generate the Production Calendar
- Integrate it with the Original Planning Engine

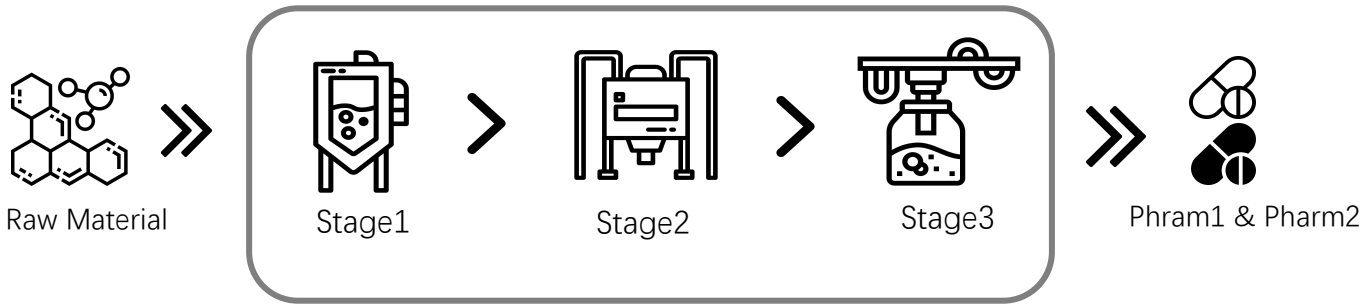
Steps

1. Clarify the Problem
2. Identify Available Data
3. Formulate Model
4. Implement Model



3. Approach

Step 1: Clarify the Problem



What are quantities that planners want to determine and monitor?

Is there any restriction in production planning?

What is the business goal?

Business Goal
- Avoid Backorder - Reduce Inventory level - Keep Enough Inventory

Quantities to be Controlled
- **How much to Produce each Month** - Inventory of (Semi)Finished Goods - Backorder of Finished Goods

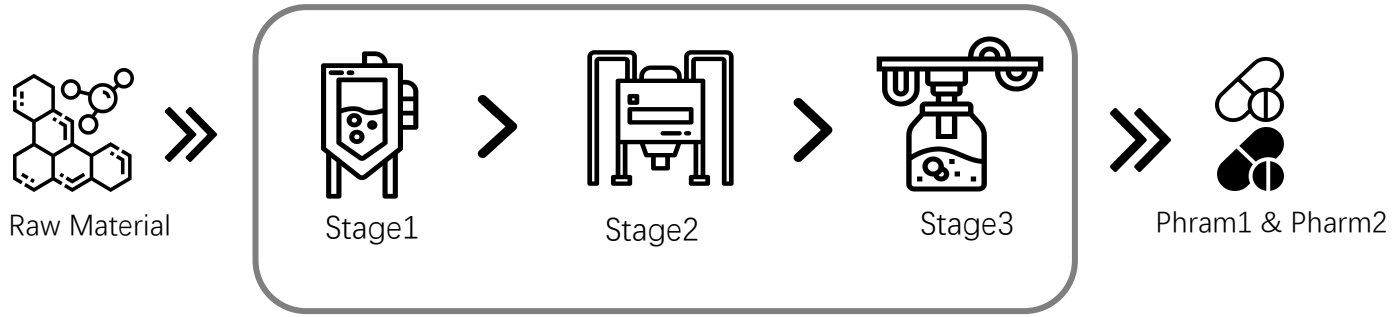
Restrictions
- Production Calendar Restriction - Production Campaign Restriction - Changeover Restriction - Production Capacity Restriction - Inventory Balance Restriction - …

3. Approach

Step 2: Identify Available Data

Cost

- Backorder Penalty Cost
- Inventory Holding Cost
- Inventory Shortage Penalty



Factory

Factory A:
- Both Stage1 and Stage2
- Maximum Production Capacity
- Initial Campaign

Factory B:
- Stage3
- Maximum Production Capacity
- Initial Campaign

Production Stage

Stage1 & Stage2:
- Changeover Time
- Minimum Campaign
- Yield Rate & Reject Rate

Stage3:
- No Changeover Time
- No Minimum Campaign
- Yield Rate & Reject Rate

Material

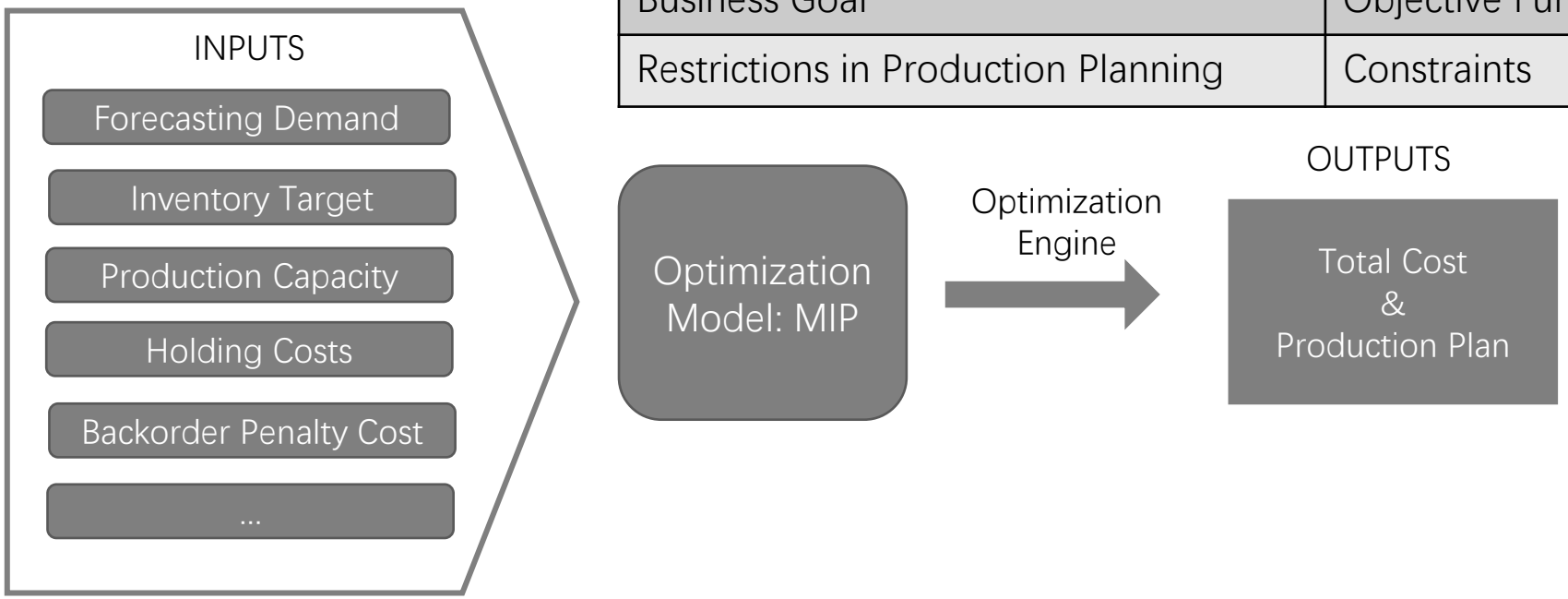
Semi-finished Goods:
- Initial Inventory
- Target Inventory

Finished Goods:
- Initial Inventory
- Safety Stock
- Forecasting Demand

3. Approach

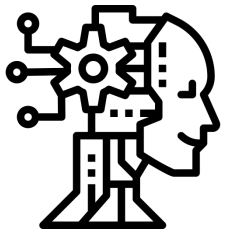
Step 3: Formulate Model

Problem Description	Optimization Model: MIP
Available Data	Parameters/Inputs of Model
Quantities to be Controlled	Decision Variables
Business Goal	Objective Function
Restrictions in Production Planning	Constraints



3. Approach

Step 4: Implement Model



Sub-Step1: Get Production Data

-Import Data from Excel Files
-Manipulate Data, e.g. Indexing, Slicing, Subsetting

Sub-Step2: Implement Optimization Model

- Build Optimization Model with Pulp
- Solve the Model

Sub-Step3: Generate Results

-Create Dataframe to Store Outputs Data

-Output Dataframe to Excel File.

4. Result

4.Result

Production Plan From Planner

Year				1												2											
Factory	Finished Goods	Stage	Decision Variable	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
A	Pharm 1	1	Produce Quantity										■	■	■										■	■	■
			inventory Shortage																								
	Pharm 1	2	Produce Quantity	■	■	■										■	■	■									
			inventory Shortage											■		■											
	Pharm 2	1	Produce Quantity				■	■	■										■	■	■	■					
			inventory Shortage																								
	Pharm 2	2	Produce Quantity							■	■	■										■	■	■			
			inventory Shortage						■																		

Production Plan From Model

Year				1												2											
Factory	Finished Goods	Stage	Decision Variable	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
A	Pharm 1	1	Produce Quantity										■	■	■										■	■	■
			inventory Shortage																								
	Pharm 1	2	Produce Quantity	■	■	■										■	■	■									
			inventory Shortage											■		■											
	Pharm 2	1	Produce Quantity				■	■	■										■	■	■	■					
			inventory Shortage																								
	Pharm 2	2	Produce Quantity							■	■	■										■	■	■			
			inventory Shortage						■																		

■ Production Plan

■ Inventory Shortage

▯ Difference

Analysis

-Similarity in Production Plan
-Difference in Production Plan

Improvement

-Get optimal production plan for about 10 minutes
-Reduced total cost by about 5%

Thank you!