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Introducing Survival Analysis Techniques for Solving Parallel Stochastic PFSPs

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Outline

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1. Introduction

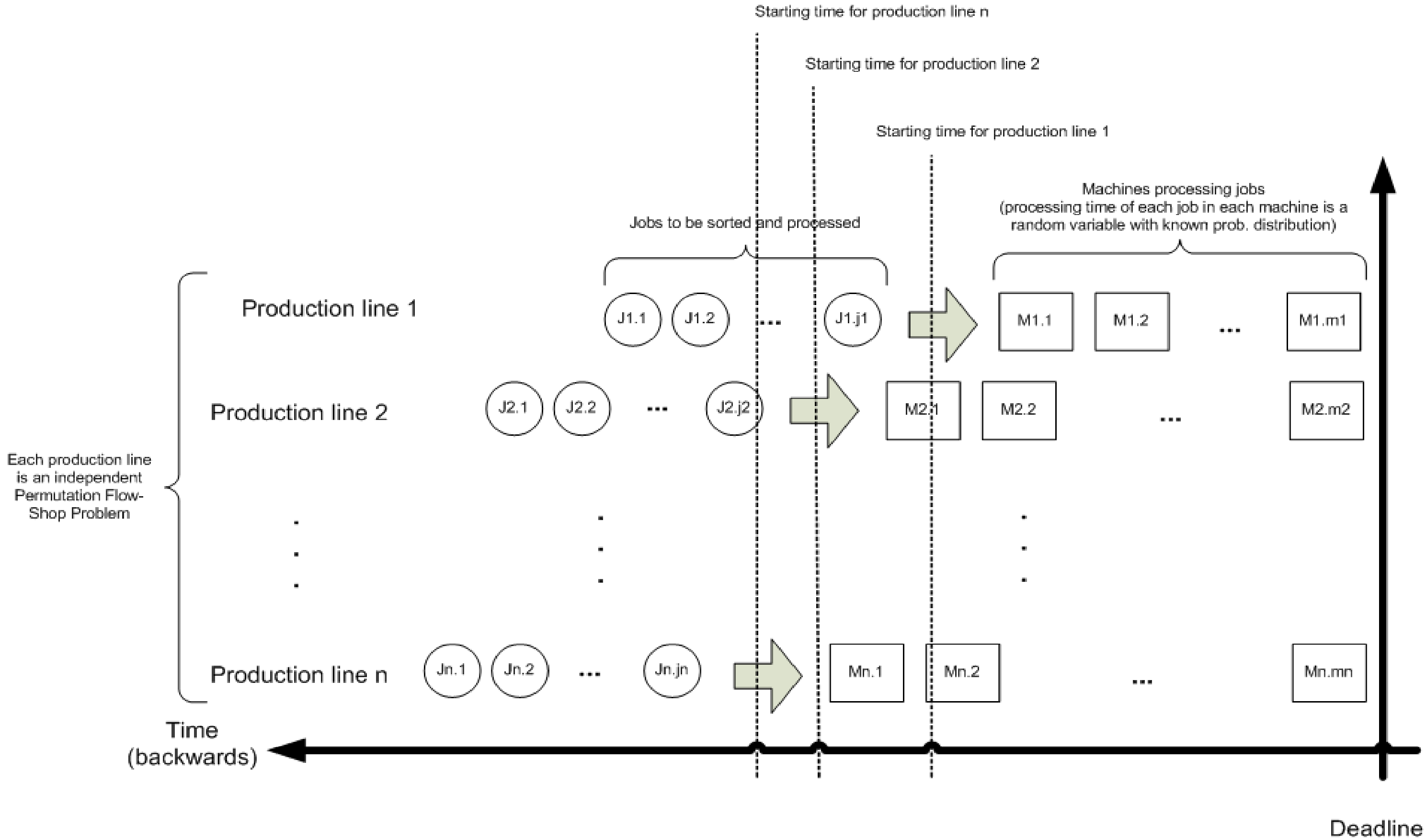
The complexity of manufacturing is becoming increasingly higher.

Frequently, we find supply chains where different companies cooperate to manufacture a product.

In a globalized economy, companies identify their core competences and outsource/purchase those activities in which they do not excel.

As a result, these products can be decomposed into a set of independent components/tasks with a common due date.

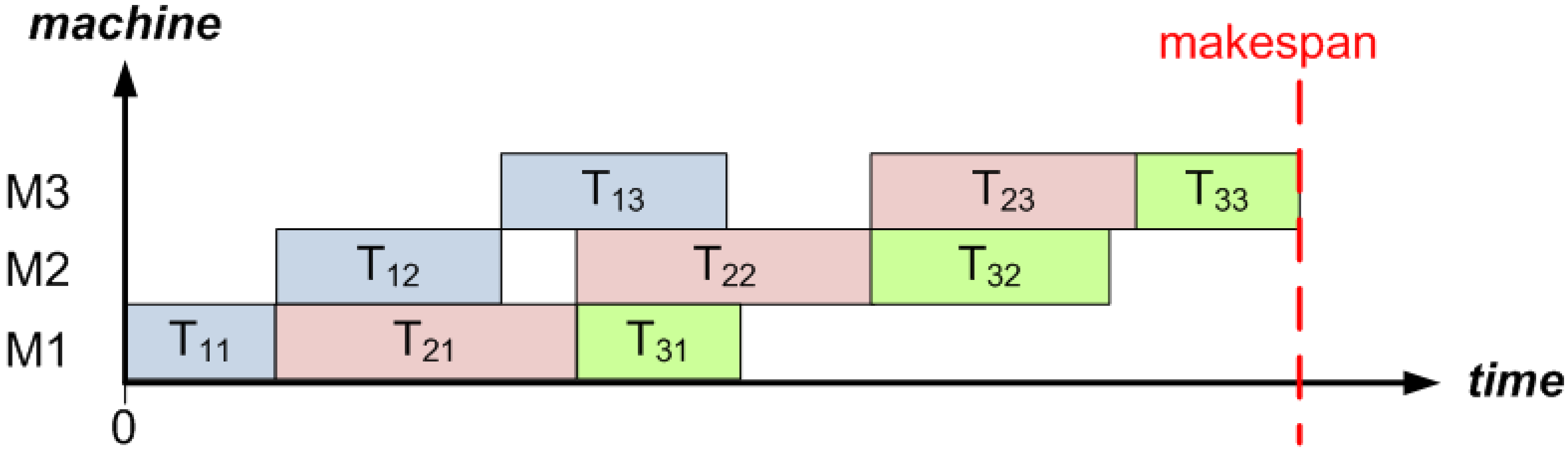
2. Problem



We assume that each of these components/tasks has to be processed in a factory, which can be modeled as a permutation flow-shop problem with random or stochastic processing times (PFSPST).

2. Problem

- PFSP



In each factory or production line k of a set F, a set J_k of n jobs has to be processed by a set M of m machines, being T_{ijk} the random variable representing the time it takes for job i of factory k to be processed by machine j.

The goal is to find a sequence (permutation) of jobs that optimizes a given criterion.

2. Problem

Minimize $\sum_{production\ line}$ time between starting times and deadline

subject to $\text{P(finishing before deadline)} \geq p$

The product is required to be finished by the deadline with a user-specified probability, p.

The decision-maker must decide about the starting times, and the permutation for each production line.

3. Methodology

Our approach:

$$Metaheuristic \ + \ Simulation + Survival\ Analysis$$

Benefits:

i. it can solve large-scale instances in reasonable computing times;

ii. it does not make any assumption either on the probability distributions employed to model the random processing times.

3. Methodology

Our methodology is based on a simheuristic approach (Juan et al. 2015), which relies on a metaheuristic and Monte Carlo simulation (MCS) techniques.

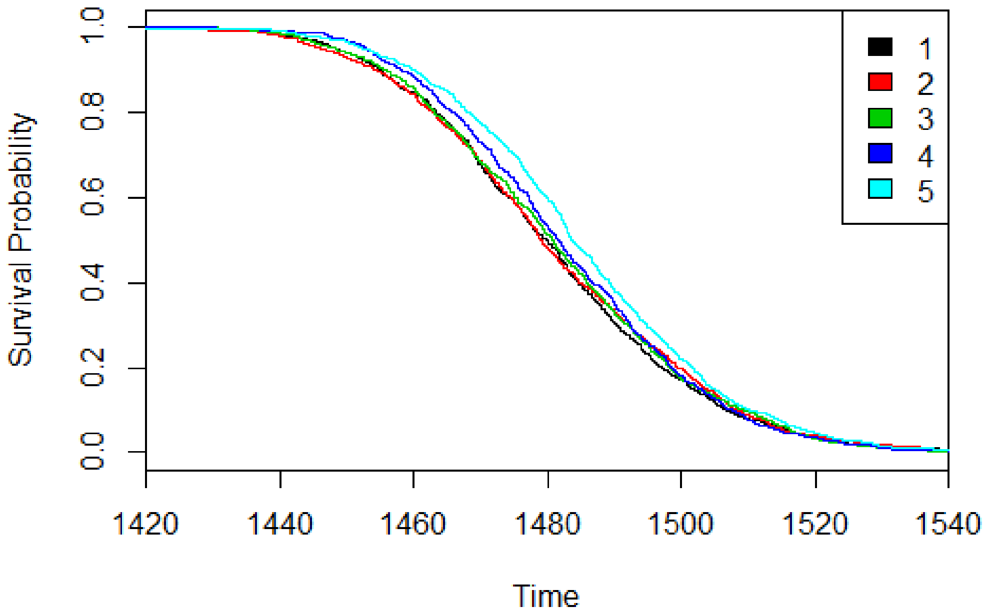
MCS techniques enable the assessment of solutions in a dynamic environment:

(1) simulate a number of scenarios;

(2) apply a specific solution in each scenario and compute a measure of performance; and

(3) return that measure.

4. 1st Approach



We tested it on an artificial instance with 5 machines and 24 jobs, assessing 1000 solutions, which takes around 23 seconds.

Top 5 solutions for a probability of 90%.

Solution	50%	85%	90%	95%
1	1479.71	1501.72	1506.79	1516.80
2	1479.07	1503.75	1508.41	1516.20
3	1480.74	1502.54	1509.24	1516.74
4	1481.61	1502.89	1507.58	1514.84
5	1483.63	1504.85	1510.10	1519.66

5. Conclusions

- We have discussed how simulation can be combined with metaheuristics in order to deal with stochastic multi-factory scheduling problems, and how introducing survival analysis techniques may improve the results.

- We have focused on a scheduling problem composed of parallel and independent components/subtasks with a common due date, the processing of each of these components being modeled as a permutation flow-shop problem with stochastic processing times.

- How to set starting times of each component in such a way that the total machine-occupancy time is minimized while ensuring a user-given probability of finishing all components in due time?

- Open research lines: e.g., correlations between processing times, assignation of products to production lines, …

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Thank you for your attention

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