# Advanced MILP Approaches for Optimizing Single-Machine Batch Scheduling with Families and Setups

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Motivated by an industrial application, this study addresses scheduling on a single batch-processing machine with limited capacity, accounting for compatible families and sequence-dependent setup times. Non-identical jobs are assigned to batches and processed simultaneously to minimize makespan. Batch duration is set by the longest job, while setups depend on the dominant families of consecutive batches. We develop and compare alternative MILP formulations strengthened through problem-specific valid inequalities. Computational results show improved solution times, quality, and scalability.

**Keywords.** Discrete and Combinatorial Optimization – Industrial Production – Parallel Batch Scheduling – MILP.