

## Lower Bounds for Tardiness Minimization on a Single Machine with Family Setup Times

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**Abstract**—In this paper, we consider the scheduling of  $N$  jobs on a single machine with family setup times in order to minimize the total tardiness. The set of jobs is divided into  $F$  families. Between two jobs of the same family, we do not have to stop the machine. However, when switching from one family to another, a setup is required. Each family is characterized by a setup time independent of the sequence. We propose a set of approaches to compute lower bounds for the tardiness criterion. These approaches are analyzed and tested on a large set of numerical experiments in order to identify the dominant lower bounds.

**Keywords**—Scheduling, Lower bounds, Family setup times, Single machine

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