FPT Approach to Minimized Makespan Scheduling with Dependencies

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Motivation and Use Cases

Scheduling for Tasks with Dependencies

Scheduling on Directed Acyclic Graphs (DAG) is a crucial problem with applications in areas such as task scheduling, parallel processing, and workflow distributions. We propose the search for a Fixed Parameter Tractable (FPT) algorithm for scheduling with dependencies. The problem as stated is:

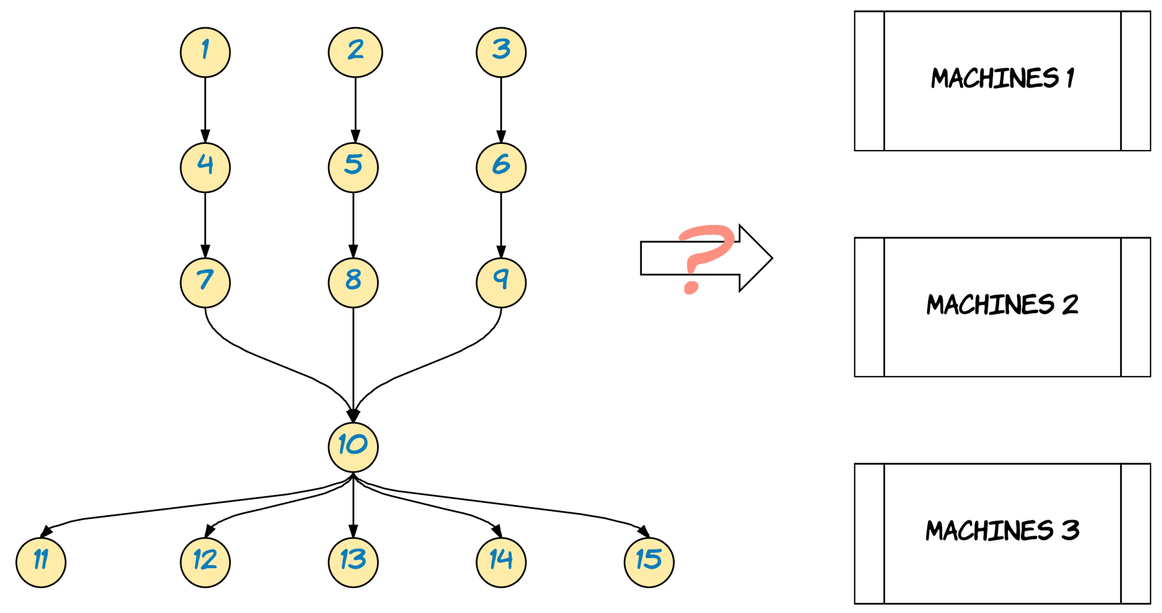
Makespan scheduling on Directed Acyclic Graph

Input: A directed graph $G = \{V, E\}$ with a function $W_v : V \rightarrow R$, where W_v is vertex weights, and a set of identical machines, M

Parameter: Tree width of $G = k$

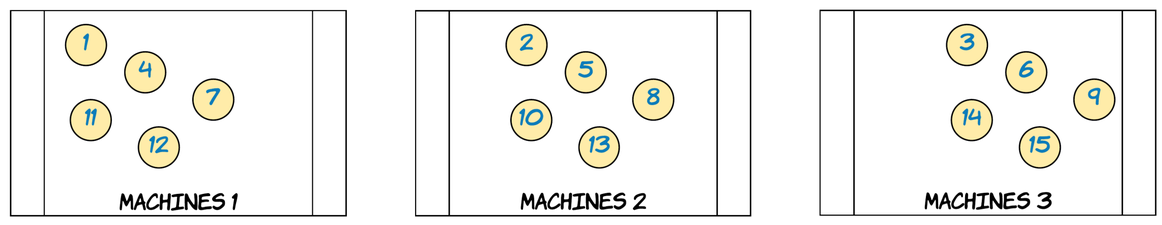
Question: Is there a Fixed Parameter Tractable algorithm parameterized by tree width which minimizes the makespan while respecting dependencies?

Given a s set of machines and dependent task



What is an optimal assignment of tasks to minimize the time to execute all of the tasks?

An optimal assignment to minimize makespan:



Related Work

To the best of our knowledge, FPT hardness results and solutions to minimized makespan scheduling still remain open problems, however, we observe that this problem is closely related to the problem of makespan scheduling without dependencies, which has been studied in the work of

Definitions

Directed Acyclic Graph (DAG) : Graph consisting of a set of directed edges with no cycles

Fixed Parameter Tractable (FPT) : A problem is FPT if when parameterized by parameter k, there is an algorithm with runtime $f(k)n^{O(1)}$.

Makespan : The total amount of time required for a set of tasks to complete, starting at the beginning of the first task, ending with the completion of the last.

Research Ideas

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