MODAPTO [101091996]: Modular Manufacturing and Distributed Control via Interoperable Digital Twins

5.5.2 Search Strategies on Production Scheduling

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Search strategies are widely used in production scheduling to quickly find good solutions by improving one solution step-by-step. These methods are useful when exact approaches become too slow, especially in real-world environments where schedules need to be adjusted often and quickly.

Local Search (LS) starts with an initial schedule and tries small modifications – such as swapping the order of two jobs or shifting a task to a different time – to improve it. The set of possible changes is known as the neighbourhood. The design of this neighbourhood is very important: a well-chosen neighbourhood helps the algorithm focus on promising directions while still allowing the search to escape from poor local solutions. In addition, local search is fast and adaptable. When disruptions occur – such as delays or machine unavailability – the current schedule can be used as a starting point, and local search can quickly adjust it to fit the new conditions. This makes local search especially valuable for real-time decision-making, where good solutions are needed in seconds or minutes rather than hours.

More advanced forms of local search use strategies to overcome local optima. For example, Variable Neighbourhood Search (VNS) changes the neighbourhood structure when the search gets stuck, giving the algorithm new ways to explore the solution space. Other techniques may accept small worsening moves to escape local traps, using methods like threshold accepting or simulated annealing principles. Simulated Annealing (SA) builds on Local Search by allowing moves that worsen the objective function, especially at the beginning of the search. It uses a temperature parameter that starts high and decreases over time. When the temperature is high, SA is more likely to accept worse solutions to escape local optima and explore a wider area of the solution space. As the temperature decreases, the algorithm becomes more selective, favouring improvements and fine-tuning the solution.

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