

abstract states, which are induced for generalizing and abstracting ground examples of schedules, allowing the use of a compact representation of the rescheduling problem. Abstract states and macro-actions for schedule repair facilitate and accelerates learning and knowledge transfer, which is independent of the type of event that has generated a disruption and can be used reactively in real-time. Finally, an additional advantage provided by the relational (deictic) representation of schedule (abstract) states and operators is that, relying in an appropriate and well designed set of background knowledge rules, it enables the automatic generation through inductive logic programming of heuristics that can be naturally understood by an end-user.

References

1. Vieira, G., Herrmann, J. Lin, E.: Rescheduling Manufacturing Systems: a Framework of Strategies, Policies and Methods. *J. of Scheduling*, 6, 39 (2003)
2. Aytug, H., Lawley, M., McKay, K., Mohan, S., Uzsoy, R.: Executing production schedules in the face of uncertainties: A review and some future directions. *European Journal of Operational Research*, 161, 86–110 (2005)
3. Henning, G.: Production Scheduling in the Process Industries: Current Trends, Emerging Challenges and Opportunities. *Computer-Aided Chemical Engineering*, 27, 23 (2009)
4. Adhitya, A., Srinivasan, R., Karimi, I. A.: Heuristic rescheduling of crude oil operations to manage abnormal supply chain events. *AIChE J.* 53(2), 397-422 (2007)
5. Miyashita, K.: Learning Scheduling Control through Reinforcements, *International Transactions in Operational Research* (Pergamon Press), 7, 125 (2000)
6. Zhu, G., Bard, J., Yu, G.: Disruption management for resource-constrained project scheduling. *Journal of the Operational Research Society*, 56, 365-381 (2005)
7. Li, Z., Ierapetritou, M.: Reactive scheduling using parametric programming. *AIChE J.* 54(10), 2610-2623 (2008)
8. Gersmann, K., Hammer, B.: Improving iterative repair strategies for scheduling with the SVM. *Neurocomputing*, 63, 271–292 (2005)
9. Morales, E. F.: Relational state abstraction for reinforcement learning. *Proceedings of the Twenty-first Intl. Conference (ICML 2004)*, Banff, Alberta, Canada, July 4-8 (2004)
10. Palombarini, J., Martínez, E.: SmartGantt – An Intelligent System for Real Time Rescheduling Based on Relational Reinforcement Learning. *Expert Systems with Applications* vol. 39, pp. 10251- 10268 (2012)
11. Džeroski, S., De Raedt, L., Driessens, K.: Relational Reinforcement Learning. *Machine Learning*, 43, No. 1/2, p. 7 (2001)
12. Van Otterlo, M.: *The Logic of Adaptive Behavior: Knowledge Representation and Algorithms for Adaptive Sequential Decision Making Under Uncertainty in First-order and Relational Domains*, IOS Press, Amsterdam (2009)
13. De Raedt, L.: *Logical and Relational Learning*. Springer-Verlag, Berlin (2008)
14. Blockeel, H., De Raedt, L.: Top-down Induction of First Order Logical Decision Trees. *Artificial Intelligence*, 101, No. 1/2, p. 285 (1998)
15. Sutton, R., Barto, A.: *Reinforcement Learning: An Introduction*. MIT Press (1998)
16. Driessens, K., Ramon, J., Blockeel, H.: Speeding up Relational Reinforcement Learning through the use of an Incremental First Order Decision Tree Learner. In: De Raedt, L. and Flach, P. (eds.) *13th Euro Conf. Machine Learning*, vol. 2167, 97, Springer, (2001)
17. Musier, R., Evans, L.: An Approximate Method for the Production Scheduling of Industrial Batch Processes with Parallel Units. *Comp. and Chem. Engineering*, 13, 229 (1989)