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A dynamic job-shop scheduling model based on deep learning

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ABSTRACT

Ideally, the solution to job-shop scheduling problem (JSP) should effectively reduce the cost of manpower and materials, thereby enhancing the core competitiveness of the manufacturer. Deep learning (DL) neural networks have certain advantages in handling complex dynamic JSPs with a massive amount of historical data. Therefore, this paper proposes a dynamic job-shop scheduling model based on DL. Firstly, a data prediction model was established for dynamic job-shop scheduling, with long short-term memory network (LSTM) as the basis; the Dropout technology and adaptive moment estimation (ADAM) were introduced to enhance the generalization ability and prediction effect of the model. Next, the dynamic JSP was described in details, and three objective functions, namely, maximum makespan, total device load, and key device load, were chosen for optimization. Finally, the multi-objective problem of dynamic JSP scheduling was solved by the improved multi-objective genetic algorithm (MOGA). The effectiveness of the algorithm was proved experimentally.

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Keywords:
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References

[1] Ahmadian, M.M., Salehipour, A., Cheng, T.C.E. (2021). A meta-heuristic to solve the just-in-time job-shop scheduling problem, *European Journal of Operational Research*, Vol. 288, No. 1, 14-29, doi: 10.1016/j.ejor.2020.04.017.
[2] Liang, Q. (2020). Production logistics management of industrial enterprises based on wavelet neural network, *Journal Européen des Systèmes Automatisés,* Vol. 53, No. 4, 581-588, doi: 10.18280/jesa.530418.
[3] Vrecko, I., Kovac, J., Rupnik, B., Gajsek, B. (2019). Using queuing simulation model in production process innovations, *International Journal of Simulation Modelling*, Vol. 18, No 1, 47-58, doi: 10.2507/IJSIMM18(1)458.
[4] Zhang, G., Zhang, L., Song, X., Wang, Y., Zhou, C. (2019). A variable neighborhood search based genetic algorithm for flexible job shop scheduling problem, *Cluster Computing*, Vol. 22, No. 5, 11561-11572, doi: 10.1007/s10586-017-1420-4.
[5] Amjad, M.K., Butt, S.I., Anjum, N., Chaudhry, I.A., Faping, Z., Khan, M. (2020). A layered genetic algorithm with iterative diversification for optimization of flexible job shop scheduling problems, *Advances in Production Engineering & Management*, Vol. 15, No. 4, 377-389, doi: 10.14743/apem2020.4.372.
[6] Ojstersek, R., Lalic, D., Buchmeister, B. (2019). A new method for mathematical and simulation modelling interactivity: A case study in flexible job shop scheduling, *Advances in Production Engineering & Management*, Vol. 14, No. 4, 435-448, doi: 10.14743/apem2019.4.339.
[7] Meolic, R., Brezočnik, Z. (2018). Flexible job shop scheduling using zero-suppressed binary decision diagrams, *Advances in Production Engineering & Management*, Vol. 13, No. 4, 373-388, doi: 10.14743/apem2018.4.297.

[8] Zhang, H., Liu, S., Moraca, S., Ojstersek, R. (2017). An effective use of hybrid metaheuristics algorithm for job shop scheduling problem, *International Journal of Simulation Modelling*, Vol. 16, No. 4, 644-657, doi: 10.2507/IJSIMM16(4)7.400.
[9] Koblasa, F., Kralikova, R., Votrubec, R. (2020). Influence of EA control parameters to optimization process of FJSSP problem, *International Journal of Simulation Modelling*, Vol. 19, No. 3, 387-398, doi: 10.2507/IJSIMM19-3-519.
[10] Asadzadeh, L. (2016). A parallel artificial bee colony algorithm for the job shop scheduling problem with a dynamic migration strategy, *Computers & Industrial Engineering*, Vol. 102, 359-367, doi: 10.1016/j.cie.2016.06.025.
[11] Kuhpfahl, J., Bierwirth, C. (2016). A study on local search neighborhoods for the job shop scheduling problem with total weighted tardiness objective, *Computers & Operations Research*, Vol. 66, 44-57, doi: 10.1016/j.cor.2015.07.011.
[12] Lei, D., Guo, X. (2016). A shuffled frog-leaping algorithm for job shop scheduling with outsourcing options, *International Journal of Production Research*, Vol. 54, No. 16, 4793-4804, doi: 10.1080/00207543.2015.1088970.
[13] Wang, C., Zeng, L. (2019). Optimization of multi-objective job-shop scheduling under uncertain environment, *Journal Européen des Systèmes Automatisés*, Vol. 52, No. 2, 179-183, doi: 10.18280/jesa.520210.
[14] Shokouhi, E. (2018). Integrated multi-objective process planning and flexible job shop scheduling considering precedence constraints, *Production & Manufacturing Research*, Vol. 6, No. 1, 61-89, doi: 10.1080/21693277.2017.1415173.
[15] Somashekhara, S.C.H., Setty, A.K.Y., Sridharmurthy, S.M., Adiga, P., Mahabaleshwar, U.S., Lorenzini, G. (2019). Makespan reduction using dynamic job sequencing combined with buffer optimization applying genetic algorithm in a manufacturing system, *Mathematical Modelling of Engineering Problems,* Vol. 6, No. 1, 29-37, doi: 10.18280/mmep.060104.
[16] Shahrabi, J., Adibi, M.A., Mahootchi, M. (2017). A reinforcement learning approach to parameter estimation in dynamic job shop scheduling, *Computers & Industrial Engineering*, Vol. 110, 75-82, doi: 10.1016/j.cie.2017.05.026.
[17] Gondran, M., Huguet, M.-J., Lacomme, P., Tchernev, N. (2019). Comparison between two approaches to solve the job shop scheduling problem with routing, *IFAC-PapersOnLine*, Vol. 52, No. 13, 2513-2518, doi: 10.1016/j.ifacol.2019.11.584.
[18] Zhong, Y., Yang, F., Liu, F. (2019). Solving multi-objective fuzzy flexible job shop scheduling problem using MABC algorithm, *Journal of Intelligent & Fuzzy Systems*, Vol. 36, No. 2, 1455-1473, doi: 10.3233/JIFS-181152.
[19] Phanden, R.K. (2016). Multi agents approach for job shop scheduling problem using genetic algorithm and variable neighborhood search method, In: *Proceedings of the 20th World Multi-Conference on Systemics, Cybernetics and Informatics,* Orlando, Florida, USA, 275-278.
[20] Bożek, A., Werner, F. (2018). Flexible job shop scheduling with lot streaming and sublot size optimisation, *International Journal of Production Research*, Vol. 56, No. 19, 6391-6411, doi: 10.1080/00207543.2017.1346322.
[21] Marzouki, B., Driss, O.B., Ghédira, K. (2018). Solving distributed and flexible job shop scheduling problem using a chemical reaction optimization metaheuristic, *Procedia Computer Science*, Vol. 126, 1424-1433, doi: 10.1016/j.procs.2018.08.114.
[22] Keddari, N., Mebarki, N., Shahzad, A., Sari, Z. (2018). Solving an integration process planning and scheduling in a flexible job shop using a hybrid approach, In: Amine, A., Mouhoub, M., Ait Mohamed, O., Djebbar, B. (eds), *Computational Intelligence and Its Applications, CIIA 2018, IFIP Advances in Information and Communication Technology,* Vol. 522, Springer, Cham, Switzerland, 387-398, doi: 10.1007/978-3-319-89743-1_34.
[23] Sreekara Reddy, M.B.S., Ratnam, C., Rajyalakshmi, G., Manupati, V.K. (2018). An effective hybrid multi objective evolutionary algorithm for solving real time event in flexible job shop scheduling problem, *Measurement*, Vol. 114, 78-90, doi: 10.1016/j.measurement.2017.09.022.
[24] Dabah, A., Bendjoudi, A., AitZai, A. (2016). Efficient parallel B&B method for the blocking job shop scheduling problem, In: *Proceedings of 2016 International Conference on High Performance Computing & Simulation (HPCS),* Innsbruck, Austria, 784-791, doi: 10.1109/HPCSim.2016.7568414.
[25] Maharana, D., Kotecha, P. (2019). Optimization of job shop scheduling problem with grey wolf optimizer and JAYA algorithm, In: Panigrahi, B., Trivedi, M., Mishra, K., Tiwari, S., Singh, P. (eds), *Smart Innovations in Communication and Computational Sciences*, *Advances in Intelligent Systems and Computing*, Vol. 669, Springer, Singapore, 47-58, doi: 10.1007/978-981-10-8968-8_5.
[26] Jahan, M.V., Dashtaki, M., Dashtaki, M. (2015). Water cycle algorithm improvement for solving job shop scheduling problem, In: *Proceedings of 2015 International Congress on Technology, Communication and Knowledge (ICTCK),* Mashhad, Iran, 576-581, doi: 10.1109/ICTCK.2015.7582732.
[27] Danielsson, F., Svensson, B., Reddy, D. (2015). A genetic algorithm with shuffle for job shop scheduling problems, In: *Proceedings of the Modelling and simulation 2015: The European simulation and modelling conference,* Leicester, United Kingdom, 363-367.
[28] Teymourifar, A., Ozturk, G., Ozturk, Z.K., Bahadir, O. (2020). Extracting new dispatching rules for multi-objective dynamic flexible job shop scheduling with limited buffer spaces, *Cognitive Computation*, Vol. 12, No. 1, 195-205, doi: 10.1007/s12559-018-9595-4.