THE APPLICATION OF COMBINED SIMULATED ANNEALING AND TABU SEARCH FOR THE FLOWSHOP SCHEDULING PROBLEM

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ABSTRACT

COMBINATORIAL OPTIMIZATION PROBLEMS ARE ENCOUNTERED IN MANY AREAS OF SCIENCE AND ENGINEERING. MOST OF THE PROBLEMS ARE TOO DIFFICULT TO BE SOLVE OPTIMALLY, AND HENCE HEURISTICS ARE USED TO OBTAIN "GOOD" SOLUTIONS IN REASONABLE TIME. IN THIS RESEARCH, A HEURISTIC WHICH COMBINES TWO WELL KNOWN LOCAL SEARCH METHODS, SIMULATED ANNEALING AND TABU SEARCH, IS PRESENTED AND APPLIED TO SOLVE THE N-JOB AND M-MACHINE FLOW SHOP SEQUENCING PROBLEM WITH THE OBJECTIVE OF MINIMIZING MAKESPAN. THE PERFORMANCE OF THE PROPOSED HEURISTIC IS COMPARED WITH SOME OTHER HEURISTICS PROPOSED SUCH AS TAILLARD'S ALGORITHM AND BF-TS, THE COMPUTATIONAL EXPERIENCE SHOWN THAT THE EFFICIENCY OF THE PRESENTED HEURISTIC IS BETTER THAN THAT OF THE OTHERS.

Keywords : HEURISTIC, SIMULATED ANNEALING, TABU SEARCH, FLOW SHOP, MAKESPAN

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REFERENCES

[1] 吳佳璋，民87，"禁忌搜尋法在彈性製造系統排程問題之應用"，大葉大學碩士學位論文。

[2] 吳文田，民89，"製造單元形成問題解決法之研究"，大葉大學碩士學位論文。

[3] 唐惠欽，陳玉偉，民87，"流程式排程啟發式演算法之分析比較"，中國工業工程學會八十七年度 年會論文集。

[4] 葉靜怡，民83，"以塔布搜尋法求解流程式工廠排程問題"，清華大學碩士學位論文。

[5] 許惇旭，民86，"結合禁忌搜尋法（ＴＳ）與模擬退火法（ＳＡ）在彈性製造系統（ＦＭＳ）排程 之應用"，大葉大學碩士學位論文。

[6] 鄧浩敦，民89，"混合基因演算法於於流程工廠排程問題之應用"，逢甲大學碩士學位論文。

[7] ADENSO-DIAZ, BELARMINO, 1996, "AN SA/TS MIXTURE ALGORITHM FOR THE SCHEDULING TARDINESS PROBLEM,"EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 88, 516-524.

[8] ARMENTANO, VINICIUS A., AND DEBORA P. RONCONI, 1999, "TABU SEARCH TOTAL TARDINESS MIN -IMIZATION IN FLOWSHOP SCHEDULING PROBLEMS," COMPUTERS & OPERATIONS RESEARCH, 26, 219 -235.

[9] ARMENTANO, VINICIUS A., AND SCRICH CINTIA RIGAO, 2000, "TABU SEARCH FOR MINIMIZING TOTAL TARDINESS IN A JOB SHOP," INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 63,131 -140.

[10] ABDINNOUR-HELM, SUE, 1998, "A HYBRID HEURISTIC FOR THE UNCAPITATED HUB LOCATION PROBL -EM," EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 82, 489-499.

[11] BEN-DAYA M., AND AL-FAWZAN, M., 1998, "A TABU SEARCH APPROACH FOR THE FLOW SHOP SCHED -ULING PROBLEM," EUROPEAN JOURNAL OPERATIONAL RESEARCH, 109, 88-95.

[12] BRAH, S. A., AND HUNSUCKER, J. L., 1991, "BRANCH AND BOUND ALGORITHM FOR THE FLOW SHOP WITH MULTIPLE PROCESSORS," EUROPEAN JOURNAL OPERATIONAL RESEARCH, 51, 88-99.

[13] CAMPBELL, H. G., DUDEK, R. A. AND SMITH, M. L., 1970, "A HEURISTIC ALGORITHM FOR THE N-JOB,M-MACHINE

SEQUENCING PROBLEM,"MANAGEMENT SCIENCE, 16, 630-637.
[14] CHANDRASEKHARAN, RAJENDRAN, 1995, "HEURISTICS FOR SCHEDULING IN FLOWSHOP WITH MULTIPL -E OBJECTIVES",EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 82, 540-555.
[15] CHEN, CHUEN-LUNG, VEMPATI, VENKATESWARA S., AND NASSER, ALJABER, 1995, "AN APPLICATIO -N OF GENETIC ALGORITHMS FOR FLOW SHOP PROBLEMS,"EUROPEAN JOURNAL OF OPERATIONAL RESE -ARCH, 80, 389-396.
[16] CHANG, FENG-CHANG R., 1996, "A STUDY OF DUE-DATE ASSIGNMENT RULES WITH CONSTRAINED TIGHTNESS IN A DYNAMIC JOB SHOP," COMPUTERS & INDUSTRIAL ENGINEERING, 31, NO.1/2, 205-208.
[17] CHENG, T.C.E., AND JIANG, J.,1998, "JOB SHOP SCHEDULING FOR MISSED DUE-DATE PERFORMA -NCE," COMPUTERS AND OPERATIONS RESEARCH, 34, NO. 2, 297-307.
[18] DILEEP, R. SULE, AND KARTHICK, VIJAYASUNDARAM, 1998, "A HEURISTIC PROCEDURE FOR MAKES -PAN MINIMIZATION IN JOB SHOPS WITH MULTIPLE IDENTICAL PROCESSORS," COMPUTERS & INDUS -TRIAL ENGINEERING, 35, NO 3-4, 399-402.
[19] EBRU, DEMIRKOL, SANJAY, MEHTA, AND REHA, UZSOY, 1998, "BENCHMARKS FOR SHOP SCHEDULING PROBLEMS," EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 109, 137-141.
[20] FEDERICO, DELLA CROCE, ROBERTO, TADEI, AND GIUSEPPE, VOLTA, 1995,"A GENETIC ALGORITHM FOR THE JOB SHOP PROBLEM," COMPUTERS AND OPERATIONS RESEARCH, 22, NO.1, 15-24.
[21] GLOVER F., 1990, "TABU SEARCH-PART I," ORSA JOURNAL ON COMPUTING, 1, 4-32.
[22] GLOVER F., 1990,"TABU SEARCH-PART II," ORSA JOURNAL ON COMPUTING, 2, 4-32.
[23] HISAO, ISHIBUCHI, SHINTA, MISAKI, AND HIDEO TANAKA, 1995, "MODIFIED SIMULATED ANNEALI -NG ALGORITHMS FOR THE FLOW SHOP SEQUENCING PROBLEM,"EUROPEAN JOURNAL OF OPERATIONAL RESEARCH , 81, 388-398.
[24] JOHN, S. M., 1954, "OPTIMAL TWO-AND THREE-STAGE PRODUCTION SCHEDULES WITH SET-UP TIME -S INCLUDED," NAVAL RESEARCH LOGISTICS QUARTERLY, 1, 61-68.
[25] JERZY, KAMBUROWSKI, 2000, "ON THREE-MACHINE FLOW SHOPS WITH RANDOM JOB PROCESSING TIMES," EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 125, 440-449.
[26] KIMT, YEONG-DAE, 1995"A BACKWARD APPROACH IN LIST SCHEDULING ALGORITHMS FOR MULTI- MACHINE TARDINESS PROBLEMS," COMPUTERS AND OPERATIONS RESEARCH, 22, NO.3, 307-319.
[27] KIMT, YD., 1993, "A NEW BRANCH AND BOUND ALGORITHM FOR MINIMIZING MEAN TARDINESS IN TWO-MACHINE FLOWSHOP," COMPUTERS AND OPERATIONS RESEARCH, 20, 391-401.
[28] LEE, CHUNG-YEE, 1999, "TWO-MACHINE FLOWSHOP SCHEDULING WITH AVAILABILITY CONSTRAINTS ,"EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 114, 420-429.
[29] LEE, H.C., AND DAGLI, CIHAN H., 1997,"A PARALLEL GENETIC-NEURO SCHEDULER FOR JOB-SHOP SCHEDULING PROBLEMS,"INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 51, 115-122.
[30] LINN, RICHARD, AND WEI, ZHANG, 1999, "HYBRID FLOW SHOP SCHEDULING:A SURVEY, " COMPUT -ERS & INDUSTRIAL ENGINEERING, 37,57-61.
[31] LOMNICKI, Z. A., 1965, "A BRANCH AND BOUND ALGORITHM FOR THE EXACT SOLUTION OF THE THREE-MACHINE SCHEDULING PROBLEM," OPERATION RESEARCH QUARTERLY, 16/1, 89-100.
[32] LAGUNA, MANUAL, KELLY, JAMES P., GONZALEZ-VELARDE, JOSE LUIS, AND GLOVER, FRED, 1995, "TABU SEARCH FOR THE MULTILEAVE GENERALIZED ASSIGNMENT PROBLEM," EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 82, 176-189.
[33] MARTIN, LAND, AND GERARD, GAALMAN, 1996, "WORKLOAD CONTROL CONCEPTS IN JOB SHOPS A CRITICAL ASSESSMENT," INTERNAL JOURNAL OF PRODUCTION ECONOMICS, 46-47, 535-548.
[34] NAWAZ, MUHAMMAD, E. EMORY , ENSCORE JR, AND INYONG , HAM, 1983, "A HEURISTIC ALGORIT -HM FOR THE M-MACHINE,N-JOB FLOW-SHOP SEQUENCING PROBLEM, " OMEGA, MANAGEMENT SCIENCE , 11,NO. 1, 91-95.
[35] PALMER, D. S., 1965, "SEQUENCING JOBS THROUGH A MULTI STAGE PROCESS IN THE MINIMUM TOTAL TIME—A QUICK METHOD OF OBTAINING A NEAR OPTIMUM," OPERATIONAL RESEARCH QUARTER -LY, 16, 101-107.
[36] REEVEST, COLIN R., 1995, "A GENETIC ALGORITHM FOR FLOWSHOP SEQUENCING,"COMPUTERS AND OPERATIONS RESEARCH, 22, NO. 1, 5-13.
[37] SHINICHI, TAGAWA, 1996, "A NEW CONCEPT OF JOB SHOP SCHEDULING SYSTEM-HIERARCHICAL DEC -ISION MODEL," INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 44, 17-26.
[38] SANTOS, D. L., HUNSUCKER, J. L. AND DEAL, D. E., 1996, "AN EVALUATION OF SEQUENCING HEURISTICS IN FLOW SHOPS WITH MULTIPLE PROCESSORS," COMPUTERS & INDUSTRIAL ENGINEE -RING, 30,NO.4, 681-692.
[39] SONG, JU-SEOG, AND LEE, TAE-EOG, 1998, "PRTRI NET MODELING AND SCHEDULING FOR CYCLIC JOB SHOPS WITH BLOCKING," COMPUTERS & INDUSTRIAL ENGINEERING, 34, NO.2, 281-295.

[40] TAILLARD, E., 1993, "BENCHMARKS FOR BASIC SCHEDULING PROBLEMS,"EUROPEAN JOURNAL OF OPERATIONAL RESEARCH, 64, 278-285.
[41] TADAHIKO, MURATA, HISAO, ISHIBUCHI AND HIDEO, TANAKA, 1996,"GENETIC ALGORITHMS FOR FLOWSHOP SCHEDULING PROBLEMS," COMPUTERS AND INDUSTRIAL ENGINEERING, 30, NO.4,1061-1071.
[42] TAKAYA, ICHIMURA, 1996, "THE ELEMENTS AND FUNCTIONS OF HIERARCHICAL SCHEDULING SYSTE -M OF ORDER PRODUCTION," INTERNATIONAL JOURNAL OF PRODUCTION ECONOMICS, 44,73-81.
[43] VERHOEVEN, M.G.A., 1998, "TABU SEARCH FOR RESOURCE -CONSTRAINED SCHEDULING," EUROPE -AN JOURNAL OF OPERATIONAL RESEARCH, 106, 266-276.
[44] VERAL, EMRE A., AND MOHAN, RAM P., 1999,"A TWO-PHASED APPROACH TO SETTING DUE-DATES IN SINGLE MACHINE JOB SHOPS," COMPUTERS & INDUSTRIAL ENGINEERING, 36, 201-218.
[45] XU, Z., AND RANDHAWA, S., 1996, "DYNAMIC JOB SHOP SCHEDULING IN A TOOL SHARED ENVIRO -NMENT," COMPUTERS & INDUSTRIAL ENGINEERING, 31, NO.1/2, 197-200.