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Nurse rostering problems – a bibliographic survey. (English) Zbl 1045.90027
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Summary: Hospitals need to repeatedly produce duty rosters for its nursing staff. The good scheduling of nurses has impact on the quality of health care, the recruitment of nurses, the development of budgets and other nursing functions. The nurse rostering problem (NRP) has been the subject of much study. This paper presents a brief overview, in the form of a bibliographic survey, of the many models and methodologies available to solve the NRP.

MSC:

90B35 Deterministic scheduling theory in operations research

Cited in **60** Documents

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Software:

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References:

- [1] S. Abdennadher, H. Schlenker, INTERDIP—an interactive constraint based nurse scheduler, in: PACLP-99. Available from <<http://www.pms.informatik.unimuenchen.de/~interdip>>, 1999
- [2] S. Abdennadher, H. Schlenker, Nurse scheduling using constraint logic programming, AAAI/IAAI, 1999, pp. 838-843
- [3] Ahuja, H.; Sheppard, R., Computerized nurse scheduling, Industrial engineering, 7, 10, 24-29, (1975)
- [4] U. Aickelin, K. Dowsland, An indirect genetic algorithm for a nurse scheduling problem, Computers and Operations Research, submitted for publication. Available from <www.inf.brad.ac.uk/~uaickeli/papers/02COR_indirect.pdf>, 2000, p. 26 · [Zbl 1048.90102](#)
- [5] Aickelin, U.; Dowsland, K., Exploiting problem structure in a genetic algorithm approach to a nurse rostering problem, Journal of scheduling, 3, 3, 139-153, (2001) · [Zbl 0965.90019](#)
- [6] U. Aickelin, Genetic algorithms for multiple-choice problems, Ph.D. thesis, University of Wales, Swansea, 1999
- [7] U. Aickelin, P. White, Building better nurse scheduling algorithms, Annals of OR, submitted for publication · [Zbl 1056.90049](#)
- [8] Anzai, M.; Miura, Y., Computer program for quick work scheduling of nursing staff, Medical information, 12, 1, 43-52, (1987)
- [9] Arthur, J.L.; Ravidran, A., A multiple objective nurse scheduling model, AIIE transactions, 13, 55-60, (1981)
- [10] Balakrishnan, N.; Wong, R.T., A network model for the rotating workforce scheduling problem, Networks, 20, 25-41, (1990)
- [11] Baker, K.R., Scheduling a full-time workforce to meet cyclic staffing requirements, Management science, 20, 1561-1568, (1974) · [Zbl 0304.90056](#)
- [12] R. Bartak, Constraint programming: In pursuit of the holy grail, in: Proceedings of WDS99, Prague, 1999, p. 10
- [13] Bartholdi, J.J.; Orlin, J.B.; Ratfill, H.D., Cyclic scheduling via integer programs with circular ones, Operations research, 28, 1074-1085, (1980) · [Zbl 0451.90075](#)
- [14] Bell, P.C.; Hay, G.; Liang, Y., A visual interactive decision support system for workforce (nurse) scheduling, Infor, 24, 134-145, (1986)
- [15] G.V. Berghe, Nurse rostering—a practical case study, undated, School of Computer Science and IT, University of Nottingham. Available from <<http://www.cs.nott.ac.uk>>
- [16] Berrada, I.; Ferland, J.A.; Michelon, P., A multi-objective approach to nurse scheduling with both hard and soft constraints, Socio-economic planning science, 30, 20, 183-193, (1996)
- [17] Beasley, J.E., Advances in linear and integer programming, (1996), Oxford University Press · [Zbl 0869.00020](#)
- [18] A. Borning, R. Duisberg, B. Freeman-Benson, K. Kramer, M. Wolf, Constraint hierarchies, in: Proceedings of ACM Conference on Object Oriented Programming Systems, Languages and Applications, ACM, 1987, pp. 48-60
- [19] Borning, A.; Freeman-Benson, B.; Wilson, M., Constraint hierarchies, LISP and symbolic computation, 5, 3, 223-270, (1992)

- [20] Burke, E.; Causmaecker, P.D.; Berghe, G.V., A hybrid tabu search algorithm for the nurse rostering problem, (), 187-194
- [21] Burke, E.; Cowling, P.; Causmaecker, P.D.; Berghe, G.V., A memetic approach to the nurse rostering problem, *Applied intelligence*, 15, 199-214, (2001) · [Zbl 0993.90506](#)
- [22] E.K. Burke, P.D. Causmaecker, S. Petrovic, G.V. Berghe, Fitness evaluation for nurse scheduling problems, in: *Proceedings of the Congress on Evolutionary Computation-CEC*, Seoul, Korea, 2001, pp. 1139-1146
- [23] Burns, R.N., Manpower scheduling with variable demands and alternate weekends off, *Infor*, 16, 101-111, (1978) · [Zbl 0384.90056](#)
- [24] Burns, R.N.; Koop, G.J., A modular approach to optimal multiple-shift manpower scheduling, *Operations research*, 35, 100-110, (1987) · [Zbl 0614.90069](#)
- [25] Chen, J.G.; Yeung, T.W., Hybrid expert-system approach to nurse scheduling, *Computers in nursing*, 11, 183-190, (1993)
- [26] B.M.W. Cheng, J.H.M. Lee, J.C.K. Wu, A constraint-based nurse rostering system using a redundant modeling approach. *8th International Conference on Tools with Artificial Intelligence (ICTAI '96)*, November 16-19, 1996, pp. 140-148
- [27] Cheng, B.M.W.; Lee, J.H.M.; Wu, J.C.K., A nurse rostering system using constraint programming and redundant modeling, *IEEE transactions in information technology in biomedicine*, 1, 1, 44-54, (1997)
- [28] A.H.W. Chun, S.H.C. Chan, G.P.S. Lam, F.M.F. Tsang, J. Wong, D.W.M. Yeung, Nurse rostering at the hospital authority of Hong Kong, *AAAI/IAAI 2000*, pp. 951-956
- [29] A. Colmerauer, An introduction to Prolog III. *Communications of the ACM*, 1990, pp. 69-90
- [30] S.J. Darmoni, A. Fajner, N. Mahe, A. Leforetier, M. Vondracek, O. Stelian, M. Baldenweck, Horoplan: Computer-assisted nurse scheduling using constraint-based programming. Available from <www.chu-rouen.fr/dsii/publi/plao.html>, 2000, p. 16
- [31] M. Dincbas, P. Van Hentenryck, H. Simonis, A. Aggoun, T. Graf, F. Berthier, The constraint logic programming language CHIP, in: *Proceedings of the International Conference on Fifth Generation Computer Systems (FGCS'88)*, Tokyo, Japan, 1988, pp. 693-702
- [32] Dowsland, K.A., Nurse scheduling with tabu search and strategic oscillation, *European journal of operational research*, 106, 393-407, (1998) · [Zbl 0991.90055](#)
- [33] Frances, S.M.A., Implementing a program of cyclical scheduling of nursing personnel, *Hospitals*, 40, 108-125, (1966)
- [34] Freuder, E.C.; Wallace, R.J., Partial constraint satisfaction, *Artificial intelligence*, 58, 1-3, 21-70, (1992)
- [35] Glover, F.; Mcmillan, C., The general employee scheduling problem: an integration of management science and artificial intelligence, *Computers and operations research*, 13, 563-573, (1986)
- [36] Glover, F.; Laguna, M., *Tabu search*, (1997), Kluwer Academic Publishers · [Zbl 0930.90083](#)
- [37] K. Heus, G. Weil, Constraint programming a nurse scheduling application, in: *Proceedings of the Second International Conference on the Practical Application of Constraint Technology*, 1996, pp. 115-127
- [38] Howell, J.P., Cyclical scheduling of nursing personnel, *Hospitals*, 40, 77-85, (1966)
- [39] Hung, R., Hospital nurse scheduling, *Journal of nursing administration*, 25, 7/8, 21-23, (1995)
- [40] ILOG, *ILOG SOLVER 4.4 Reference Manual*, 1999
- [41] W.K. Jackson, W.S. Havens, H. Dollard, Staff scheduling: A simple approach that worked. Available from <<http://www.cs.sfu.ca/research/groups/ta/staff/node1.html>>, 1997
- [42] Jaffar, J.; Maher, M.J., Constraint logic programming: A survey, *Journal of logic programming*, 19/20, 503-581, (1994)
- [43] Jaffar, J.; Michaylov, S.; Stuckey, P.J.; Yap, R.H.C., The CLP (R) language and system, *ACM transactions on programming languages and systems*, 14, 3, 339-395, (1992)
- [44] Jaumard, B.; Semet, F.; Vovor, T., A generalized linear programming model for nurse scheduling, *European journal of operational research*, 107, 1-18, (1998) · [Zbl 0943.90032](#)
- [45] Jelinek, R.C.; Kavous, J.A., Nurse staffing and scheduling: past solutions and future directions, *Journal of the society for health systems*, 3, 75-82, (1992)
- [46] A. Jan, M. Yamamoto, A. Ohuchi, Evolutionary algorithms for nurse scheduling problem. in: *Proceedings of the 2000 Congress on Evolutionary Computation CEC00*, IEEE Press, 2000, pp. 196-203. Available from <<http://www.lania.mx/~ccoello/EMOO/jan00.ps.gz>> 8 pp
- [47] Kostreva, M.M.; Jennings, K.S.B., Nurse scheduling on a microcomputer, *Computers and operations research*, 18, 8, 731-739, (1991) · [Zbl 0729.91033](#)
- [48] L. Kragelund, T. Kabel, Employee timetabling, Master's thesis in computer science, University of Aarhus, 1998
- [49] Kumar, V., Algorithms for constraint satisfaction problems: A survey, *AI magazine*, 13, 1, 32-44, (1992)
- [50] S. Kusumoto, Nurse scheduling system using ILOG Solver, in: *Proceedings of the Second ILOG Solver and Scheduler Users Conference*, Paris, 1996, p. 6. Available from <www.ilog.com/products/optimization/tech/custpapers/nec.pdf>
- [51] J.M. Lazaro, P. Aristondo, Using Solver for nurse scheduling, *ILOG Solver and ILOG Schedule*, First International Users' Conference Proceedings, 1995, p. 10
- [52] Linear programming frequently asked questions, Optimization Technology Center of Northwestern University and Argonne National Laboratory. Available from <<http://www-unix.mcs.anl.gov/otc/Guide/faq/linear-programming-faq.html>>
- [53] Lawler, E.W.; Wood, D.E., Branch-and-bound methods: A survey, *Operations research*, 14, 699-719, (1966) · [Zbl 0143.42501](#)
- [54] Lukman, D.; May, J.H.; Shuman, L.J.; Wolfe, H.B., Knowledge-based schedule formulation and maintenance under uncertainty,

- Journal of society of health systems, 2, 2, 42-64, (1991)
- [55] Mailer-Rothe, C.; Wolfe, H.B., Cyclical scheduling and allocation of nursing staff, *Socio-economic planning science*, 7, 471-487, (1973)
- [56] Marchionno, P.M., Modified cyclical scheduling: A practical approach, *Nursing management*, 18, 60-66, (1987)
- [57] Meyer auf'm Hofe, H., Nurse rostering as constraint satisfaction with fuzzy constraints and inferred control strategies, (), 67-99 · [Zbl 0983.90042](#)
- [58] H. Meyer auf'm Hofe, ConPlan/SIEDAplan: Personal assignment as a problem of hierarchical constraint satisfaction, in: *Proceedings of the Third International Conference on the Practical Application of Constraint Technology*, 1997, pp. 257-272
- [59] Michalewicz, Z., *Genetic algorithms + data structures = evolutionary programs*, (1997), Springer-Verlag
- [60] Millar, H.; Kiragu, M., Cyclic and non-cyclic scheduling of 12 h shift nurses by network programming, *European journal of operational research*, 104, 3, 582-592, (1992) · [Zbl 0955.90027](#)
- [61] Miller, H.E.; William, P.; Gustave, J.R., Nurse scheduling using mathematical programming, *Operations research*, 24, 5, 857-870, (1976) · [Zbl 0337.90034](#)
- [62] Monroe, G., Scheduling manpower for service operations, *Industrial engineering*, 2, 8, 10-17, (1970)
- [63] P. Moscato, On evolution, search, optimization, genetic algorithms and martial arts: Towards memetic algorithms, Technical Report C3P 826, Pasadena, CA, 1989
- [64] Musa, A.A.; Saxena, U., Scheduling nurses using goal-programming techniques, *IIE transactions*, 16, 216-221, (1984)
- [65] Nonlinear programming frequently asked questions, Optimization Technology Center of Northwestern University and Argonne National Laboratory. Available from <<http://www-unix.mcs.anl.gov/otc/Guide/faq/nonlinear-programming-faq.html>>
- [66] Nonobe, K.; Ibaraki, T., A tabu search approach to the constraint satisfaction problem as a general problem solver, *European journal of operational research*, 106, 599-623, (1998) · [Zbl 0991.90102](#)
- [67] Okada, M., An approach to the generalized nurse scheduling problem—generation of a declarative program to represent institution-specific knowledge, *Computer and biomedical research*, 25, 5, 417-434, (1992)
- [68] Okada, Mihoko; Okada, Masahiko, Prolog-based system for nursing staff scheduling implemented on a personal computer, *Computer and biomedical research*, 21, 53-63, (1988)
- [69] Oldenkamp, J.H., Quality in fives: on the analysis, operationalization and application of nursing schedule quality, (1996), University of Groningen
- [70] Ozkarahan, I.; Bailey, J.E., A multi-objective approach to nurse scheduling with both hard and soft constraints, *IIE transactions*, 20, 3, 306-316, (1988)
- [71] Radcliffe, N.J.; Surry, P.D., Formal memetic algorithms, (), 1-16
- [72] Randhawa, S.U.; Sitompul, D., A heuristic based computerized nurse scheduling system, *Computers and operations research*, 20, 8, 837-844, (1983)
- [73] ()
- [74] Rosenbloom, E.S.; Goertzen, N.F., Cyclic nurse scheduling, *European journal of operational research*, 31, 19-23, (1987)
- [75] S. Scott, R. Simpson, Case-bases Incorporating Scheduling Constraint Dimensions—Experiences in Nurse Rostering, *EWCBR*, 1998, pp. 392-401
- [76] Sitompul, D.; Randhawa, S., Nurse scheduling models: A state-of-the-art review, *Journal of the society of health systems*, 2, 62-72, (1990)
- [77] Smith, L.D.; Wiggins, A., A computer-based nurse scheduling system, *Computers and operations research*, 4, 195-212, (1977)
- [78] Soft constraints in the nurse Rostering problem, Full description of all the constraint types in use in Plane System, February 6, 2001. Available from <<http://www.cs.nott.ac.uk/~gvb/constraints.ps>>
- [79] F.E. Tackling, Scheduling problems using integer programming, Master Thesis, University of Wales, Swansea, 1998
- [80] Thompson, G.M., A simulated annealing heuristic for shift-scheduling using non-continuously available employees, *Computers and operations research*, 23, 275-288, (1996) · [Zbl 0855.90073](#)
- [81] Valouxis, C.; Housos, E., Hybrid optimization techniques for the workshift and rest assignment of nursing personnel, *Artificial intelligence in medicine*, 20, 155-175, (2000)
- [82] Van Hentenryck, P., *Constraint satisfaction in logic programming*, (1989), MIT Press Cambridge, MA
- [83] Warner, D.M.; Prawda, J., A mathematical programming model for scheduling nursing personnel in a hospital, *Management science*, 19, 4, 411-422, (1972) · [Zbl 0246.90022](#)
- [84] Warner, D.M., Scheduling nursing personnel according to nursing preference: A mathematical programming approach, *Operations research*, 24, 5, 842-856, (1976) · [Zbl 0337.90033](#)
- [85] Weil, G.; Heus, K.; Francois, P.; Poujade, M., Constraint programming for nurse scheduling, *IEEE transactions in engineering in medicine and biology*, 417-422, (1995)

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