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Pattern mining for label ranking

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Bibliography

- [1] T. Abudawood and P. A. Flach. Evaluation measures for multi-class subgroup discovery. In *Machine Learning and Knowledge Discovery in Databases, European Conference, ECML PKDD 2009, Bled, Slovenia, September 7-11, 2009, Proceedings, Part I*, pages 35–50, 2009.
- [2] R. Agrawal, T. Imielinski, and A. N. Swami. Mining association rules between sets of items in large databases. In *Proceedings of the 1993 ACM SIGMOD International Conference on Management of Data, Washington, D.C., May 26-28, 1993.*, pages 207–216, 1993.
- [3] R. Agrawal, H. Mannila, R. Srikant, H. Toivonen, and A. I. Verkamo. Fast discovery of association rules. In *Advances in Knowledge Discovery and Data Mining*, pages 307–328. AAAI/MIT Press, 1996.
- [4] R. Agrawal and R. Srikant. Fast algorithms for mining association rules in large databases. In *VLDB'94, Proceedings of 20th International Conference on Very Large Data Bases, September 12-15, 1994, Santiago de Chile, Chile*, pages 487–499, 1994.
- [5] A. Agresti. *Analysis of ordinal categorical data*. Wiley series in probability and mathematical statistics. J. Wiley, Hoboken, 2010.
- [6] A. Aiguzhinov, C. Soares, and A. P. Serra. A similarity-based adaptation of naive bayes for label ranking: Application to the metalearning problem of algorithm recommendation. In *Discovery Science - 13th International Conference, DS 2010, Canberra, Australia, October 6-8, 2010. Proceedings*, pages 16–26, 2010.
- [7] R. Arens. Learning SVM ranking functions from user feedback using document metadata and active learning in the biomedical domain. In *Preference Learning.*, pages 363–383. Springer, 2010.
- [8] M. Z. Ashrafi, D. Taniar, and K. A. Smith. Redundant association rules reduction techniques. In *AI 2005: Advances in Artificial In-*

- telligence, 18th Australian Joint Conference on Artificial Intelligence, Sydney, Australia, December 5-9, 2005, Proceedings*, pages 254–263, 2005.
- [9] P. J. Azevedo and A. M. Jorge. Comparing rule measures for predictive association rules. In *Machine Learning: ECML 2007, 18th European Conference on Machine Learning, Warsaw, Poland, September 17-21, 2007, Proceedings*, pages 510–517, 2007.
 - [10] P. J. Azevedo and A. M. Jorge. Ensembles of jittered association rule classifiers. *Data Min. Knowl. Discov.*, 21(1):91–129, 2010.
 - [11] P. L. Bartlett and M. H. Wegkamp. Classification with a reject option using a hinge loss. *Journal of Machine Learning Research*, 9:1823–1840, 2008.
 - [12] S. D. Bay. Multivariate discretization for set mining. *Knowl. Inf. Syst.*, 3(4):491–512, 2001.
 - [13] G. Biau. Analysis of a random forests model. *Journal of Machine Learning Research*, 13:1063–1095, 2012.
 - [14] R. I. Brafman. Preferences, planning and control. In *Principles of Knowledge Representation and Reasoning: Proceedings of the Eleventh International Conference, KR 2008, Sydney, Australia, September 16-19, 2008*, pages 2–5, 2008.
 - [15] F. Brandenburg, A. Gleißner, and A. Hofmeier. Comparing and aggregating partial orders with kendall tau distances. *Discrete Math., Alg. and Appl.*, 5(2), 2013.
 - [16] P. Brazdil and C. Soares. Exploiting Past Experience in Ranking Classifiers. In H. Bacelar-Nicolau, F. C. Nicolau, and J. Janssen, editors, *Applied Stochastic Models and Data Analysis*, pages 299–304. Instituto Nacional de Estatística, 1999.
 - [17] P. Brazdil, C. Soares, and J. P. da Costa. Ranking learning algorithms: Using IBL and meta-learning on accuracy and time results. *Machine Learning*, 50(3):251–277, 2003.
 - [18] L. Breiman. Bagging predictors. *Machine Learning*, 24(2):123–140, 1996.
 - [19] L. Breiman. Random forests. *Machine Learning*, 45(1):5–32, 2001.
 - [20] L. Breiman, J. H. Friedman, R. A. Olshen, and C. J. Stone. *Classification and Regression Trees*. Wadsworth, 1984.

- [21] S. Brin, R. Motwani, J. D. Ullman, and S. Tsur. Dynamic itemset counting and implication rules for market basket data. In *SIGMOD 1997, Proceedings ACM SIGMOD International Conference on Management of Data, May 13-15, 1997, Tucson, Arizona, USA.*, pages 255–264, 1997.
- [22] J. Cerquides and R. L. de Mántaras. Proposal and empirical comparison of a parallelizable distance-based discretization method. In *Proceedings of the Third International Conference on Knowledge Discovery and Data Mining (KDD-97), Newport Beach, California, USA, August 14-17, 1997*, pages 139–142, 1997.
- [23] W. Cheng. *Label Ranking with Probabilistic Models*. PhD dissertation, Philipps-Universität Marburg Fachbereich Mathematik und Informatik, 2012.
- [24] W. Cheng, K. Dembczynski, and E. Hüllermeier. Label ranking methods based on the plackett-luce model. In *Proceedings of the 27th International Conference on Machine Learning (ICML-10), June 21-24, 2010, Haifa, Israel*, pages 215–222, 2010.
- [25] W. Cheng, S. Henzgen, and E. Hüllermeier. Labelwise versus pairwise decomposition in label ranking. In *LWA 2013. Lernen, Wissen & Adaptivität, Workshop Proceedings Bamberg, 7.-9. October 2013*, pages 129–136, 2013.
- [26] W. Cheng, J. C. Huhn, and E. Hüllermeier. Decision tree and instance-based learning for label ranking. In *Proceedings of the 26th Annual International Conference on Machine Learning, ICML 2009, Montreal, Quebec, Canada, June 14-18, 2009*, pages 161–168, 2009.
- [27] W. Cheng and E. Hüllermeier. Label ranking with abstention: Predicting partial orders by thresholding probability distributions (extended abstract). *Computing Research Repository, CoRR*, abs/1112.0508, 2011.
- [28] W. Cheng, E. Hüllermeier, W. Waegeman, and V. Welker. Label ranking with partial abstention based on thresholded probabilistic models. In *Advances in Neural Information Processing Systems 25: 26th Annual Conference on Neural Information Processing Systems 2012. Proceedings of a meeting held December 3-6, 2012, Lake Tahoe, Nevada, United States.*, pages 2510–2518, 2012.

- [29] D. K. Y. Chiu, B. Cheung, and A. K. C. Wong. Information synthesis based on hierarchical maximum entropy discretization. *J. Exp. Theor. Artif. Intell.*, 2(2):117–129, 1990.
- [30] S. Clémençon, M. Depecker, and N. Vayatis. Ranking forests. *Journal of Machine Learning Research*, 14(1):39–73, 2013.
- [31] J. C. de Borda. Mémoire sur les élections au scrutin. 1781.
- [32] C. R. de Sá, C. Soares, A. Knobbe, and P. Cortez. Label ranking forests. *Expert Systems*, pages n/a–n/a, 2016.
- [33] C. R. de Sá. Mining association rules for label ranking. Master’s thesis, Faculty of Sciences, University of Porto, 2010.
- [34] C. R. de Sá, W. Duivesteijn, C. Soares, and A. J. Knobbe. Exceptional preferences mining. In *Discovery Science - 19th International Conference, DS 2016, Bari, Italy, October 19-21, 2016, Proceedings*, pages 3–18, 2016.
- [35] C. R. de Sá, C. Rebelo, C. Soares, and A. J. Knobbe. Distance-based decision tree algorithms for label ranking. In *Progress in Artificial Intelligence - 17th Portuguese Conference on Artificial Intelligence, EPIA 2015, Coimbra, Portugal, September 8-11, 2015. Proceedings*, pages 525–534, 2015.
- [36] C. R. de Sá, C. Soares, A. M. Jorge, P. J. Azevedo, and J. P. da Costa. Mining association rules for label ranking. In *Advances in Knowledge Discovery and Data Mining - 15th Pacific-Asia Conference, PAKDD 2011, Shenzhen, China, May 24-27, 2011, Proceedings, Part II*, pages 432–443, 2011.
- [37] C. R. de Sá, C. Soares, A. M. Jorge, P. J. Azevedo, and A. Knobbe. Preference rules. *submitted to Information Fusion Journal*, 2017.
- [38] C. R. de Sá, C. Soares, and A. Knobbe. Permutation tests for label ranking. In *Proceedings of the 27th Benelux Conference on Artificial Intelligence (BNAIC 2015)*, 2015.
- [39] C. R. de Sá, C. Soares, and A. J. Knobbe. Entropy-based discretization methods for ranking data. *Inf. Sci.*, 329:921–936, 2016.
- [40] C. R. de Sá, C. Soares, A. J. Knobbe, P. J. Azevedo, and A. M. Jorge. Multi-interval discretization of continuous attributes for label ranking. In *Discovery Science - 16th International Conference, DS 2013, Singapore, October 6-9, 2013. Proceedings*, pages 155–169, 2013.

- [41] O. Dekel, C. D. Manning, and Y. Singer. Log-linear models for label ranking. In *Advances in Neural Information Processing Systems 16 [Neural Information Processing Systems, NIPS 2003, December 8-13, 2003, Vancouver and Whistler, British Columbia, Canada]*, pages 497–504, 2003.
- [42] K. Dembczynski, W. Kotlowski, R. Slowinski, and M. Szelag. Learning of rule ensembles for multiple attribute ranking problems. In *Preference Learning.*, pages 217–247. Springer, 2010.
- [43] J. Demsar. Statistical comparisons of classifiers over multiple data sets. *Journal of Machine Learning Research*, 7:1–30, 2006.
- [44] S. Destercke. A pairwise label ranking method with imprecise scores and partial predictions. In *Machine Learning and Knowledge Discovery in Databases - European Conference, ECML PKDD 2013, Prague, Czech Republic, September 23-27, 2013, Proceedings, Part II*, pages 112–127, 2013.
- [45] A. Dinno. *dunn.test: Dunn’s Test of Multiple Comparisons Using Rank Sums*, 2015. R package version 1.2.3.
- [46] J. Dougherty, R. Kohavi, and M. Sahami. Supervised and unsupervised discretization of continuous features. In *Machine Learning, Proceedings of the Twelfth International Conference on Machine Learning, Tahoe City, California, USA, July 9-12, 1995*, pages 194–202, 1995.
- [47] J. Doyle. Prospects for preferences. *Computational Intelligence*, 20(2):111–136, 2004.
- [48] W. Duivesteijn. *Exceptional Model Mining*. PhD thesis, Leiden University, 2013.
- [49] W. Duivesteijn, A. Feelders, and A. J. Knobbe. Exceptional model mining - supervised descriptive local pattern mining with complex target concepts. *Data Min. Knowl. Discov.*, 30(1):47–98, 2016.
- [50] W. Duivesteijn and A. J. Knobbe. Exploiting false discoveries - statistical validation of patterns and quality measures in subgroup discovery. In *11th IEEE International Conference on Data Mining, ICDM 2011, Vancouver, BC, Canada, December 11-14, 2011*, pages 151–160, 2011.
- [51] C. Dwork, R. Kumar, M. Naor, and D. Sivakumar. Rank aggregation methods for the web. In *Proceedings of the Tenth International World Wide Web Conference, WWW 10, Hong Kong, China, May 1-5, 2001*, pages 613–622, 2001.

- [52] V. Dzyuba and M. van Leeuwen. Interactive discovery of interesting subgroup sets. In *Advances in Intelligent Data Analysis XII - 12th International Symposium, IDA 2013, London, UK, October 17-19, 2013. Proceedings*, pages 150–161, 2013.
- [53] T. Elomaa and J. Rousu. Efficient multisplitting revisited: Optima-preserving elimination of partition candidates. *Data Min. Knowl. Discov.*, 8(2):97–126, 2004.
- [54] U. M. Fayyad and K. B. Irani. Multi-interval discretization of continuous-valued attributes for classification learning. In *Proceedings of the 13th International Joint Conference on Artificial Intelligence. Chambéry, France, August 28 - September 3, 1993*, pages 1022–1029, 1993.
- [55] J. C. Fodor and M. R. Roubens. *Fuzzy preference modelling and multicriteria decision support*, volume 14 of *Theory and Decision Library D*. Springer Netherlands, Dordrecht, 1994.
- [56] J. Fürnkranz and E. Hüllermeier. Pairwise preference learning and ranking. In *Machine Learning: ECML 2003, 14th European Conference on Machine Learning, Cavtat-Dubrovnik, Croatia, September 22-26, 2003, Proceedings*, pages 145–156, 2003.
- [57] J. Fürnkranz and E. Hüllermeier, editors. *Preference Learning*. Springer, 2010.
- [58] J. Fürnkranz, E. Hüllermeier, E. Loza Mencía, and K. Brinker. Multilabel classification via calibrated label ranking. *Machine Learning*, 73(2):133–153, 2008.
- [59] J. Fürnkranz, E. Hüllermeier, and S. Vanderlooy. Binary decomposition methods for multipartite ranking. In *Machine Learning and Knowledge Discovery in Databases, European Conference, ECML PKDD 2009, Bled, Slovenia, September 7-11, 2009, Proceedings, Part I*, pages 359–374, 2009.
- [60] S. García, J. Luengo, J. A. Sáez, V. López, and F. Herrera. A survey of discretization techniques: Taxonomy and empirical analysis in supervised learning. *IEEE Trans. Knowl. Data Eng.*, 25(4):734–750, 2013.
- [61] R. Genuer, J. Poggi, and C. Tuleau-Malot. Variable selection using random forests. *Pattern Recognition Letters*, 31(14):2225–2236, 2010.

- [62] A. Gionis, H. Mannila, T. Mielikäinen, and P. Tsaparas. Assessing data mining results via swap randomization. *TKDD*, 1(3), 2007.
- [63] P. Golland, F. Liang, S. Mukherjee, and D. Panchenko. Permutation tests for classification. In *Learning Theory, 18th Annual Conference on Learning Theory, COLT 2005, Bertinoro, Italy, June 27-30, 2005, Proceedings*, pages 501–515, 2005.
- [64] M. Gurrieri, X. Siebert, P. Fortemps, S. Greco, and R. Slowinski. Label ranking: A new rule-based label ranking method. In *Advances on Computational Intelligence - 14th International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems, IPMU 2012, Catania, Italy, July 9-13, 2012. Proceedings, Part I*, pages 613–623, 2012.
- [65] M. Halkidi and M. Vazirgiannis. Quality assessment approaches in data mining. In *The Data Mining and Knowledge Discovery Handbook.*, pages 661–696. Springer, 2005.
- [66] J. Han and M. Kamber. *Data Mining: Concepts and Techniques*. Morgan Kaufmann, 2000.
- [67] J. Han, J. Pei, Y. Yin, and R. Mao. Mining frequent patterns without candidate generation: A frequent-pattern tree approach. *Data Min. Knowl. Discov.*, 8(1):53–87, 2004.
- [68] S. Har-Peled, D. Roth, and D. Zimak. Constraint classification: A new approach to multiclass classification. In *Algorithmic Learning Theory, 13th International Conference, ALT 2002, Lübeck, Germany, November 24-26, 2002, Proceedings*, pages 365–379, 2002.
- [69] T. Hastie, R. Tibshirani, and J. Friedman. *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, chapter Unsupervised Learning, pages 485–585. Springer New York, New York, NY, 2009.
- [70] S. Henzgen and E. Hüllermeier. Mining rank data. In *Discovery Science - 17th International Conference, DS 2014, Bled, Slovenia, October 8-10, 2014. Proceedings*, pages 123–134, 2014.
- [71] J. Hipp, U. Güntzer, and G. Nakhaeizadeh. Algorithms for association rule mining - A general survey and comparison. *SIGKDD Explorations*, 2(1):58–64, 2000.
- [72] K. M. Ho and P. D. Scott. Zeta: A global method for discretization of continuous variables. In *Proceedings of the Third International Con-*

- ference on Knowledge Discovery and Data Mining (KDD-97), Newport Beach, California, USA, August 14-17, 1997*, pages 191–194, 1997.
- [73] W. Huang, Y. Pan, and J. Wu. Supervised discretization for optimal prediction. *Procedia Computer Science*, 30:75 – 80, 2014.
 - [74] E. Hüllermeier, J. Fürnkranz, W. Cheng, and K. Brinker. Label ranking by learning pairwise preferences. *Artif. Intell.*, 172(16-17):1897–1916, 2008.
 - [75] M. Iqbal, I. Mukhlash, and H. M. Astuti. The comparison of cba algorithm and cbs algorithm for meteorological data classification. *ISICO 2013*, 2013.
 - [76] F. Jiang and Y. Sui. A novel approach for discretization of continuous attributes in rough set theory. *Knowl.-Based Syst.*, 73:324–334, 2015.
 - [77] N. Jin, P. A. Flach, T. Wilcox, R. Sellman, J. Thumim, and A. J. Knobbe. Subgroup discovery in smart electricity meter data. *IEEE Trans. Industrial Informatics*, 10(2):1327–1336, 2014.
 - [78] T. Joachims. Optimizing search engines using clickthrough data. In *Proceedings of the Eighth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, July 23-26, 2002, Edmonton, Alberta, Canada*, pages 133–142, 2002.
 - [79] A. M. Jorge, F. Pereira, and P. J. Azevedo. Visual interactive subgroup discovery with numerical properties of interest. In *Discovery Science, 9th International Conference, DS 2006, Barcelona, Spain, October 7-10, 2006, Proceedings*, pages 301–305, 2006.
 - [80] R. J. B. Jr., R. Agrawal, and D. Gunopulos. Constraint-based rule mining in large, dense databases. *Data Min. Knowl. Discov.*, 4(2/3):217–240, 2000.
 - [81] T. Kamishima. Nantonac collaborative filtering: recommendation based on order responses. In *Proceedings of the Ninth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Washington, DC, USA, August 24 - 27, 2003*, pages 583–588, 2003.
 - [82] T. Kamishima, H. Kazawa, and S. Akaho. A survey and empirical comparison of object ranking methods. In *Preference Learning.*, pages 181–201. Springer, 2010.
 - [83] A. Karatzoglou and M. Weimer. Collaborative preference learning. In *Preference Learning.*, pages 409–427. Springer, 2010.

- [84] J. Kemeny and J. Snell. *Mathematical Models in the Social Sciences*. MIT Press, 1972.
- [85] M. Kendall and J. Gibbons. *Rank correlation methods*. Griffin London, 1970.
- [86] R. Kerber. Chimerge: Discretization of numeric attributes. In *Proceedings of the 10th National Conference on Artificial Intelligence. San Jose, CA, July 12-16, 1992.*, pages 123–128, 1992.
- [87] W. Klösgen. Explora: A multipattern and multistrategy discovery assistant. In *Advances in Knowledge Discovery and Data Mining*, pages 249–271. American Association for Artificial Intelligence, 1996.
- [88] W. Klösgen and J. M. Zytkow, editors. *Handbook of Data Mining and Knowledge Discovery*. Oxford University Press, New York, NY, USA, 2002.
- [89] W. Kotlowski, K. Dembczynski, and E. Hüllermeier. Bipartite ranking through minimization of univariate loss. In *Proceedings of the 28th International Conference on Machine Learning, ICML 2011, Bellevue, Washington, USA, June 28 - July 2, 2011*, pages 1113–1120, 2011.
- [90] S. Kotsiantis and D. Kanellopoulos. Discretization techniques: A recent survey. *GESTS International Transactions on Computer Science and Engineering*, 32(1):47–58, 2006.
- [91] G. Lebanon and J. D. Lafferty. Conditional models on the ranking poset. In *Advances in Neural Information Processing Systems 15 [Neural Information Processing Systems, NIPS 2002, December 9-14, 2002, Vancouver, British Columbia, Canada]*, pages 415–422, 2002.
- [92] M. D. Lee, M. Steyvers, and B. Miller. A cognitive model for aggregating people’s rankings. *Public Library of Science, PLOS ONE*, 9(5):e96431, 2014.
- [93] W. H. K. Leo A. Goodman. Measures of association for cross classifications. *Journal of the American Statistical Association*, 49(268):732–764, 1954.
- [94] B. Letham, T. H. McCormick, C. Rudin, and D. Madigan. Building interpretable classifiers with rules using bayesian analysis, 2012.
- [95] W. Li, J. Han, and J. Pei. CMAR: accurate and efficient classification based on multiple class-association rules. In *Proceedings of the*

- 2001 IEEE International Conference on Data Mining, 29 November - 2 December 2001, San Jose, California, USA*, pages 369–376, 2001.
- [96] M. Lichman. UCI machine learning repository, 2013.
 - [97] B. Liu, W. Hsu, and Y. Ma. Integrating classification and association rule mining. In *Proceedings of the Fourth International Conference on Knowledge Discovery and Data Mining (KDD-98), New York City, New York, USA, August 27-31, 1998*, pages 80–86, 1998.
 - [98] B. Liu, W. Hsu, and Y. Ma. Mining association rules with multiple minimum supports. In *Proceedings of the Fifth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, San Diego, CA, USA, August 15-18, 1999*, pages 337–341, 1999.
 - [99] H. Liu and R. Setiono. Feature selection via discretization. *IEEE Trans. Knowl. Data Eng.*, 9(4):642–645, 1997.
 - [100] H. Mannila and H. Toivonen. Levelwise search and borders of theories in knowledge discovery. *Data Min. Knowl. Discov.*, 1(3):241–258, 1997.
 - [101] M. Meeng and A. Knobbe. Flexible enrichment with cortana—software demo. In *Proceedings of BeneLearn*, pages 117–119, 2011.
 - [102] T. M. Mitchell. *Machine learning*. McGraw Hill series in computer science. McGraw-Hill, 1997.
 - [103] A. M. Molinaro, R. Simon, and R. M. Pfeiffer. Prediction error estimation: a comparison of resampling methods. *Bioinformatics*, 21(15):3301–3307, 2005.
 - [104] H. Neave and P. Worthington. *Distribution-free Tests*. Routledge, 1992.
 - [105] M. Ojala and G. C. Garriga. Permutation tests for studying classifier performance. *Journal of Machine Learning Research*, 11:1833–1863, 2010.
 - [106] E. Omiecinski. Alternative interest measures for mining associations in databases. *IEEE Trans. Knowl. Data Eng.*, 15(1):57–69, 2003.
 - [107] J. S. Park, M. Chen, and P. S. Yu. An effective hash based algorithm for mining association rules. In *Proceedings of the 1995 ACM SIGMOD International Conference on Management of Data, San Jose, California, May 22-25, 1995.*, pages 175–186, 1995.
 - [108] J. S. Park, M. Chen, and P. S. Yu. Efficient parallel and data mining for association rules. In *CIKM '95, Proceedings of the 1995 International*

- Conference on Information and Knowledge Management, November 28 - December 2, 1995, Baltimore, Maryland, USA*, pages 31–36, 1995.
- [109] J. Pei, J. Han, and L. V. S. Lakshmanan. Mining frequent item sets with convertible constraints. In *Proceedings of the 17th International Conference on Data Engineering, April 2-6, 2001, Heidelberg, Germany*, pages 433–442, 2001.
 - [110] J. Pinto da Costa and C. Soares. A weighted rank measure of correlation. *Australian and New Zealand Journal of Statistics*, 47(4):515–529, 2005.
 - [111] J. R. Quinlan. Induction of decision trees. *Machine Learning*, 1(1):81–106, 1986.
 - [112] J. R. Quinlan. *C4.5: Programs for Machine Learning*. Morgan Kaufmann, 1993.
 - [113] R Core Team. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria, 2015.
 - [114] F. Radlinski and T. Joachims. Query chains: learning to rank from implicit feedback. In *Proceedings of the Eleventh ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Chicago, Illinois, USA, August 21-24, 2005*, pages 239–248, 2005.
 - [115] C. Rebelo, C. Soares, and J. Costa. Empirical Evaluation of Ranking Trees on Some Metalearning Problems. In J. Chomicki, V. Conitzer, U. Junker, and P. Perny, editors, *Proceedings 4th AAAI Multidisciplinary Workshop on Advances in Preference Handling*, 2008.
 - [116] G. Ribeiro, W. Duivesteijn, C. Soares, and A. J. Knobbe. Multilayer perceptron for label ranking. In *Artificial Neural Networks and Machine Learning - ICANN 2012 - 22nd International Conference on Artificial Neural Networks, Lausanne, Switzerland, September 11-14, 2012, Proceedings, Part II*, pages 25–32, 2012.
 - [117] E. Scornet, G. Biau, and J.-P. Vert. Consistency of random forests. *ArXiv e-prints*, May 2014.
 - [118] C. Spearman. The proof and measurement of association between two things. *American Journal of Psychology*, 15:72–101, 1904.
 - [119] S. Thomas and S. Sarawagi. Mining generalized association rules and sequential patterns using SQL queries. In *Proceedings of the Fourth International Conference on Knowledge Discovery and Data Mining*

- (KDD-98), New York City, New York, USA, August 27-31, 1998, pages 344–348, 1998.
- [120] L. Todorovski, H. Blockeel, and S. Dzeroski. Ranking with predictive clustering trees. In *Machine Learning: ECML 2002, 13th European Conference on Machine Learning, Helsinki, Finland, August 19-23, 2002, Proceedings*, pages 444–455, 2002.
 - [121] L. Umek and B. Zupan. Subgroup discovery in data sets with multi-dimensional responses. *Intell. Data Anal.*, 15(4):533–549, 2011.
 - [122] T. L. Van, M. van Leeuwen, S. Nijssen, A. C. Fierro, K. Marchal, and L. D. Raedt. Ranked tiling. In *Machine Learning and Knowledge Discovery in Databases - European Conference, ECML PKDD 2014, Nancy, France, September 15-19, 2014. Proceedings, Part II*, pages 98–113, 2014.
 - [123] S. Vembu and T. Gärtner. Label ranking algorithms: A survey. In *Preference Learning.*, pages 45–64. Springer, 2010.
 - [124] F. L. Wauthier, M. I. Jordan, and N. Jojic. Efficient ranking from pairwise comparisons. In *Proceedings of the 30th International Conference on Machine Learning, ICML 2013, Atlanta, GA, USA, 16-21 June 2013*, pages 109–117, 2013.
 - [125] G. I. Webb. Discovering significant rules. In *Proceedings of the Twelfth ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, Philadelphia, PA, USA, August 20-23, 2006*, pages 434–443, 2006.
 - [126] S. Yasutake, K. Hatano, E. Takimoto, and M. Takeda. Online rank aggregation. In *Proceedings of the 4th Asian Conference on Machine Learning, ACML 2012, Singapore, Singapore, November 4-6, 2012*, pages 539–553, 2012.
 - [127] Y. Zhou, Y. Liu, X. Z. Gao, and G. Qiu. A label ranking method based on gaussian mixture model. *Knowl.-Based Syst.*, 72:108–113, 2014.