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DAG representation of asymmetric independence models arising in coherent conditional possibility theory. (English) Zbl 1334.68216

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Summary: In this paper we study the representation by means of an acyclic directed graph (DAG) of the independence model induced by a coherent T -conditional possibility (where T stands for the minimum or a strict t-norm). Such models are in general not closed under symmetric property, so we must rely on a proper asymmetric notion of vertex separation which produces structures closed under all graphoid properties and their reverses except for symmetry (namely, asymmetric graphoids). Focusing on this kind of models we present an efficient procedure to generate and represent them symbolically. We then introduce asymmetric Markov properties and prove their equivalence, providing in this way a method to extract the model encoded in a DAG. Finally, an algorithm to build a minimal T -map, given an ordering of the random variables, is drawn.

MSC:

68T37 Reasoning under uncertainty in the context of artificial intelligence

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Keywords:

graphical models; coherent conditional possibility; independence models; asymmetric graphoid; acyclic directed graph; fast closure; asymmetric Markov properties; possibilistic network

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References:

- [1] Biaoletti, M.; Busanello, G.; Vantaggi, B., Conditional independence structure and its closure: inferential rules and algorithms, *Int. J. Approx. Reason.*, 50, 7, 1097-1114, (2009) · [Zbl 1185.62009](#)
- [2] Biaoletti, M.; Busanello, G.; Vantaggi, B., Acyclic directed graphs representing independence models, *Int. J. Approx. Reason.*, 52, 1, 2-18, (2011) · [Zbl 1209.68354](#)
- [3] Biaoletti, M.; Busanello, G.; Vantaggi, B., Exploiting independencies to compute semigraphoid and graphoid structures, *Int. J. Approx. Reason.*, 52, 5, 565-579, (2011) · [Zbl 1216.62006](#)
- [4] Biaoletti, M.; Coletti, G.; Petturiti, D.; Vantaggi, B., Inferential models and relevant algorithms in a possibilistic framework, *Int. J. Approx. Reason.*, 52, 5, 580-598, (2011) · [Zbl 1214.68393](#)
- [5] Biaoletti, M.; Petturiti, D., Algorithms for possibility assessments: coherence and extension, *Fuzzy Sets Syst.*, 169, 1, 125, (2011) · [Zbl 1214.68394](#)
- [6] Ben Amor, N.; Benferhat, S., Graphoid properties of qualitative possibilistic independence relations, *Int. J. Uncertain. Fuzziness Knowl.-Based Syst.*, 13, 1, 59-96, (2005) · [Zbl 1096.68147](#)
- [7] Ben Amor, N.; Mellouli, K.; Benferhat, S.; Dubois, D.; Prade, H., A theoretical framework for possibilistic independence in a weakly ordered setting, *Int. J. Uncertain. Fuzziness Knowl.-Based Syst.*, 10, 2, 117-155, (2002) · [Zbl 1084.68126](#)
- [8] Benferhat, S., Interventions and belief change in possibilistic graphical models, *Artif. Intell.*, 174, 2, 177-189, (2010)
- [9] Benferhat, S.; Dubois, D.; Garcia, L.; Prade, H., On the transformation between possibilistic logic bases and possibilistic causal networks, *Int. J. Approx. Reason.*, 29, 2, 135-173, (2002) · [Zbl 1015.68204](#)
- [10] Benferhat, S.; Smaoui, S., Hybrid possibilistic networks, *Int. J. Approx. Reason.*, 44, 3, 224-243, (2007) · [Zbl 1116.68094](#)
- [11] Borgelt, C.; Steinbrecher, M.; Kruse, R., Graphical models: representations for learning, reasoning and data mining, (2009), John Wiley & Sons · [Zbl 1269.62014](#)
- [12] Bouchon-Meunier, B.; Coletti, G.; Marsala, C., Independence and possibilistic conditioning, *Ann. Math. Artif. Intell.*, 35, 107-123, (2002) · [Zbl 1004.60001](#)
- [13] Cobb, B. R.; Shenoy, P. P., Operations for inference in continuous Bayesian networks with linear deterministic variables, *Int. J. Approx. Reason.*, 42, 1-2, 21-36, (2006) · [Zbl 1110.68146](#)
- [14] Coletti, G.; Petturiti, D.; Vantaggi, B., Possibilistic and probabilistic likelihood functions and their extensions: common features and specific characteristics, *Fuzzy Sets Syst.*, 250, 25-51, (2014), this volume · [Zbl 1334.60004](#)
- [15] Coletti, G.; Scozzafava, R., From conditional events to conditional measures: A new axiomatic approach, *Ann. Math. Artif.*

- Intell., 32, 1, 373-392, (2001) · [Zbl 1314.68306](#)
- [16] Coletti, G.; Scozzafava, R., Probabilistic logic in a coherent setting, Trends Log., vol. 15, (2002), Kluwer Academic Publishers Dordrecht/Boston/London · [Zbl 1005.60007](#)
- [17] Coletti, G.; Vantaggi, B., Possibility theory: conditional independence, Fuzzy Sets Syst., 157, 11, 1491-1513, (2006) · [Zbl 1092.68094](#)
- [18] Coletti, G.; Vantaggi, B., T-conditional possibilities: coherence and inference, Fuzzy Sets Syst., 160, 3, 306-324, (2009) · [Zbl 1178.60006](#)
- [19] Cowell, R. G.; Dawid, A. P.; Lauritzen, S. L.; Spiegelhalter, D. J., Probabilistic networks and expert systems, (1999), Springer-Verlag New York, NY, USA · [Zbl 0937.68121](#)
- [20] Cox, D. R.; Wermuth, N., Multivariate dependencies - models, analysis, and interpretation, (1996), Chapman and Hall · [Zbl 0880.62124](#)
- [21] Cozman, F. G.; Walley, P., Graphoid properties of epistemic irrelevance and independence, Ann. Math. Artif. Intell., 45, 173-195, (2005) · [Zbl 1097.68128](#)
- [22] Dawid, A. P., Conditional independence in statistical theory, J. R. Stat. Soc., 41, 1-31, (1979) · [Zbl 0408.62004](#)
- [23] De Baets, B.; Tsiporkova, E.; Mesiar, R., Conditioning in possibility theory with strict order norms, Fuzzy Sets Syst., 106, 2, 221-229, (1999) · [Zbl 0985.28015](#)
- [24] de Campos, L. M.; Castellano, J. G., Bayesian network learning algorithms using structural restrictions, Int. J. Approx. Reason., 45, 2, 233-254, (2007) · [Zbl 1122.68104](#)
- [25] de Campos, L. M.; Huete, J. F., Independence concepts in possibility theory: part I, Fuzzy Sets Syst., 103, 1, 127-152, (1999) · [Zbl 0951.68150](#)
- [26] de Cooman, G., Possibility theory II: conditional possibility, Int. J. Gen. Syst., 25, 325-351, (1997) · [Zbl 0955.28013](#)
- [27] de Cooman, G., Integration and conditioning in numerical possibility theory, Ann. Math. Artif. Intell., 32, 1-4, 87-123, (2001) · [Zbl 1314.28012](#)
- [28] de Finetti, B.; de Finetti, B., Probability, induction and statistics, Ann. Univ. Trieste, 19, 3-55, (1972), Wiley London, Chapter 5
- [29] Dubois, D.; Prade, H., Possibility theory, (1988), Plenum Press New York · [Zbl 0645.68108](#)
- [30] Dubois, D.; Prade, H., Bayesian conditioning in possibility theory, Fuzzy Sets Syst., 92, 2, 223-240, (1997) · [Zbl 1053.62503](#)
- [31] Feelders, A.; van der Gaag, L. C., Learning Bayesian network parameters under order constraints, Int. J. Approx. Reason., 42, 1-2, 37-53, (2006) · [Zbl 1096.68697](#)
- [32] Ferracuti, L.; Vantaggi, B., Independence and conditional possibility for strictly monotone triangular norms: research articles, Int. J. Intell. Syst., 21, 3, 299-323, (2006) · [Zbl 1088.60003](#)
- [33] Hisdal, E., Conditional possibilities independence and noninteraction, Fuzzy Sets Syst., 1, 4, 283-297, (1978) · [Zbl 0393.94050](#)
- [34] Klement, E. P.; Mesiar, R.; Pap, E., Triangular norms, Trends Log., vol. 8, (2000), Kluwer Academic Publisher Dordrecht/Boston/London · [Zbl 0972.03002](#)
- [35] Lauritzen, S. L., Graphical models, (1996), Clarendon Press Oxford · [Zbl 0907.62001](#)
- [36] Moral, S.; Cano, A., Strong conditional independence for credal sets, Ann. Math. Artif. Intell., 35, 1-4, 295-321, (2002) · [Zbl 1005.60006](#)
- [37] Pearl, J., Probabilistic reasoning in intelligent systems: networks of plausible inference, (1988), Morgan Kaufmann Publishers Inc. San Francisco, CA, USA
- [38] Petturiti, D., Asymmetric decomposability and persegam representation in coherent conditional probability theory, Soft Comput., 17, 11, 2131-2145, (2013) · [Zbl 1410.68354](#)
- [39] Petturiti, D., Coherent conditional possibility theory and possibilistic graphical modeling in a coherent setting, (2013), Università degli Studi di Perugia, PhD thesis
- [40] Shenoy, P. P., Conditional independence in valuation-based systems, Int. J. Approx. Reason., 10, 3, 203-234, (1994) · [Zbl 0821.68114](#)
- [41] Studený, M., Semigraphoids and structures of probabilistic conditional independence, Ann. Math. Artif. Intell., 21, 71-98, (1997) · [Zbl 0888.68112](#)
- [42] Studený, M., Complexity of structural models, (Proceedings of Prague Stochastics '98, (1998)), 521-528
- [43] Studený, M., Probabilistic conditional independence structures, (2005), Springer-Verlag London, UK · [Zbl 1070.62001](#)
- [44] Studený, M.; Bouckaert, R. R., On chain graph models for description of conditional independence structures, Ann. Stat., 26, 4, 1434-1495, (1998) · [Zbl 0930.62066](#)
- [45] Vantaggi, B., Conditional independence in a coherent finite setting, Ann. Math. Artif. Intell., 32, 1-4, 287-313, (2001) · [Zbl 1314.60012](#)
- [46] Vantaggi, B., The L-separation criterion for description of cs-independence models, Int. J. Approx. Reason., 29, 3, 291-316, (2002) · [Zbl 1014.62002](#)
- [47] Vantaggi, B., Conditional independence structures and graphical models, Int. J. Uncertain. Fuzziness Knowl.-Based Syst., 11, 5, 545-571, (2003) · [Zbl 1072.68101](#)
- [48] Vantaggi, B., Graphical representation of asymmetric graphoid structures, (Third International Symposium on Imprecise

Probabilities and Their Applications, (2003)), 560-574

- [49] Vantaggi, B., Qualitative Bayesian networks with logical constraints, (Nielsennd, T. D.; Zhang, N. L., Symbolic and Quantitative Approaches to Reasoning with Uncertainty, Lecture Notes in Computer Science, vol. 2711, (2004), Springer Berlin/Heidelberg), 100-112 · [Zbl 1274.68557](#)
- [50] Vantaggi, B., The role of coherence for handling probabilistic evaluations and independence, *Soft Comput.*, 9, 8, 617-628, (2005) · [Zbl 1084.60007](#)
- [51] Vejnarová, J., Conditional independence relations in possibility theory, *Int. J. Uncertain. Fuzziness Knowl.-Based Syst.*, 8, 3, 253-269, (2000) · [Zbl 1113.68536](#)
- [52] Vejnarová, J., Markov properties and factorization of possibility distributions, *Ann. Math. Artif. Intell.*, 35, 1-4, 357-377, (2002) · [Zbl 1014.68155](#)
- [53] Walley, P.; de Cooman, G., Coherence of rules for defining conditional possibility, *Int. J. Approx. Reason.*, 21, 1, 63-107, (1999) · [Zbl 0957.68115](#)
- [54] Witthaker, J., Graphical models in applied multivariate statistic, (1990), Wiley \& Sons New York, NY, USA
- [55] Wong, S. K.M.; Butz, C. J.; Wu, D., On the implication problem for probabilistic conditional independency, *IEEE Trans. Syst. Man Cybern., Part A, Syst. Hum.*, 30, 6, 785-805, (2000)
- [56] Zadeh, L. A., Fuzzy sets as a basis for a theory of possibility, *Fuzzy Sets Syst.*, 1, 1, 3-28, (1978) · [Zbl 0377.04002](#)

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