

A Roadmap to Research on Bayesian Networks and other Decomposable Probabilistic Models

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Abstract

This paper is a listing of literature on Bayesian Networks and related graphical probability models. It is my own personal notes and is continually changing, but feel free to grab a copy. If you have additions or corrections, please let me know.

[RG: This has NOT been updated since around Dec'96.]

1 Network Representations Defined

1.1 General Properties of Conditional Independence

Graphical Axioms of C.I.: [Daw79], [Daw80], [Spo80], [GP88], [Pea88b], [Smi89], [Smi90] **Critical Graph Theoretical Properties:** [LSV84], [Spe79] *Hyper-Markov laws:* [DL93b], [HB94b] *Mathematical properties of Markov Fields:* [Ish81], [Lau82] **Causal Independence:** [HB94b]

1.2 Bayesian Networks

General overviews: [Cha91], [HH88], [HBH91], [HBH88], [Pea87a], [Pea88b], [Pea93], [Jen93] **Structure Definitions:** [KP83], [Pea86b], [Pea88b], [GVP90] **Inter-causal structure:** [MD90], [D'A91]. **Noisy-OR:** [Pea86b], [Pea88b], [PR86], [Die93], [Sri92], [Sri93], [HS93], [Ago91], [ZP94], [Hec93], **Additive Models:** [DG93a], [HT87], [DGH92], [DG93a] **Alternative Representations:** [KS95] **Independence relations implied in Bayesian Network graphs** [PP85], [PV87], [Pea86b],

1.3 Influence Diagrams

Influence Diagrams include decision nodes and a value (utility) node. [HM84] [How90], [PGV90], [Smi90], [Pro93b], [Ken86], [TS90], [BG95], [ZQP93b], [She92], [SP92], [Ndi94], [SN93], [JJD94]

1.4 Undirected Networks

Also known as Markov Networks. [DLS80], [LS88], [Pea88b]

1.5 Alternative Representations of probability distributions

Chain Graphs: (Hybrid directed-undirected): Also known as “block recursive Markov random fields.” [KSC84] (studies a special case — recursive causal graphs. Only top ancestors can be connected with undirected edges, all others by directed edges), [LW89], [WL89], [WL90], [Fry90], [Bun95b], [Mee95] **Directed Cyclic Graphs:** [Spi94, Spi95], [PD96] **Similarity Networks:** [Hec90a], [Hec90b], [GH91], [GH93]

Decision-Tree: [Jir94] **Balloon Graphs:** Described in [She93]. Invented by G. Shafer 1993, but that book is apparently not yet published.

1.6 Networks of Non-probabilistic representations of Uncertainty

(These involve mostly generalizations of point probability) **Qualitative Networks:** [Wel90a], [Wel90b], [Wel90c], [PM93], [Par95] **Belief Functions:** [Dem90], [Kon86], [Mel87], [SS86], [SSM87], [SS90], [Wil90], [Xu91], [ZHS88], [WD94b], [SSS95], [Sri95] **Convex Probabilities:** [BF91], [CDM91], [CMVL93], [CDM93], [FB93], [Tes92], [dCM95], [Chr96] **Previsions:** [Gol90] **Second-Order Distributions:** [Mus93], [NK91] **Generalized Axiomatizations:** (These generalize most of the above types of networks) [She93], [SS86], [SS90], [SE91] **Potential Influence Diagrams:** [SN93] [She92], [SP92], [Ndi94], [JJD94]

1.7 Specialized Network Forms

1.7.1 Temporal Bayesian Network

Where identical stage is replicated multiple times over time: [AR90], [KD89], [KNL⁺93], [Kja92], [Kja95a], [OL92], [NB94], [Fun88], [DGH92], [Pro93b], [HKM⁺94], [DBL90], [NB92], [DG93b], [BBQ89], (embeds Semi-Markov model), [Ken86], [TS90], [Hec93], [HHNK95], [NHH95], [KKR95], Markov Decision Processes (MDPs) with each state an influence diagram: [Pro93a].

1.8 Classical Statistical Uses

(e.g., Hypothesis testing, etc) [DLS80], [Lau82], [LW89], [BIS90]

1.9 Continuous variables and parametric distributions

Gaussians: [SK89], [AHSE93], [DM95] (mixture), [CF91], [Lau92], [GH94b] **CG-Distributions:** [LW89], [Ole93], **Exponential Families:** [Bun95a], [Whi90], **Issues of Conjugacy:** Dawid's response to [LS88], **Continuous Belief-Function Densities:** [WD94b], [WD94a], **others:** [AFS94], [KSC84], [GH94a], [GH95a], [Ken86],

1.10 Philosophical Issues

1.10.1 Causality and Control

refs: [Pea88a], [Pea94b], [Pea94a], [Pea95b], [Pea95a], [SGS93], [DS93], [HS94], [CS92], [BP94], [BP95], [GP95], [GP96], [HB94b], [Pea96] [Sto93]

1.10.2 Modeling

Various critiques and/or criticisms on the problems and issues involved in designing or using a graphical model: [Spe90].

1.10.3 Other

Counterfactuals [Bal95]

1.11 Important Relationships to Other formalisms

To Hidden Markov models [SHJ96].

2 Solution Techniques

Unification of Existing Techniques: [SAS94]

2.1 Types of Queries

2.2 Exact Marginals or Policies

2.2.1 Propagation on Specialized Forms

Causal Polytrees: [Pea86b], [Pea88b], [DGKP95]

2.2.2 Junction-Tree Propagation

Method of Compiling a propagation graph from a general network with (undirected) loops: [Spi86], [LS88], [Spi90], [Daw92], [Jen94], [JJD94], [JJ94], [JOA90], [AK93], [JLO90], [Bon87], [Dra95], [SL90]

2.2.3 Cutset-Conditioning

Method for dealing with undirected loops: [Pea86a], [Pea88b, pg. 204–210], [ZP92], [BG94], [Dar95], [Dear], [SC90], [PS91], [Dar94a]

2.2.4 Arc Reversal

General method for solving Influence diagrams: [Sha86], [Sha90] [FB93], [BF91], [Mus93]

2.2.5 Symbolic Solution

Surprisingly, some good results have emerged by symbolically manipulating equations defining a joint probability distribution, much like Mathematica might do. [CF91], [SDD90], [D'A90], [D'A94] [LS88, Comments by W. S. Kendall], [CGH95]

2.3 Exact Optimization

Finding the best (highest probability) configuration.

2.3.1 Junction-Tree Propagation

Max propagation: [DDP90], [Daw92]

2.3.2 Linear Programming

Formalizations as linear or non-linear programming problems: [San94], [LD94]

2.4 Approximation

2.4.1 Stochastic Simulation

Markov Chain Monte-Carlo based techniques (mostly Gibbs Sampling): [GG84], [CC87], [CC90], [Pea87b], [DC93], [DH93], [JKK93], [DH92], [Hry90], [Nea93], [DKL95], [Kja95b], [KKR95], [MC96]. (Of these, [JKK93, JKK95, MC96, DKL95, JKK93, JKK95, Kja95b] can be viewed as being a combinations of Gibbs sampling and exact propagation.) **Logic Sampling:** [Hen88] **Likelihood Weighting:** [FC89], [SP89] **Backward Simulation:** [FDF94] **Mean Field Theory:** [SJ95], [SJJ96]. **Monte Carlo for Dempster-Shafer:** [Wil91] **MCMC for Dempster-Shafer:** [MW94]

2.4.2 Structure Alteration or Abstraction

Simplifying the network structure to obtain an approximation: [Kja93], [Kja94], [PFH94], [WL94], [Pro93b], [Sar93], [Lam94], Removal of Small Probabilities: [JA90], [CBS95] **Quality of an Abstraction:** [KV95], [Las91], [Las93], [LL94]

2.4.3 Approximation of Cutset-Conditioning

By taking only a subsample of the conditioning variables' values: [Dar94b, GD95]

2.4.4 Heuristic

Searching for optimums using heuristic search: [DDP90], [Hen91] Using Genetic Algorithms: [RK93] Using Laplace's Method: [AFS94]

2.4.5 Anytime Algorithms

Various approaches for anytime computation: [Poo93], [DH94] (gets bounds from looking only at a subset of the network, expanding subset with time).

2.5 Theoretical Complexity

NP-Hardness results: [Coo87], [Coo90], [DL93a],[Shi94], [VP93] (Note: [Ros75] actually proved the NP-hardness of exact solution by proving NP-hardness of a special case called fault trees. However, [Coo87] is the better known result.)

2.6 Other forms of queries

2.6.1 Value of Information

How valuable would one additional piece of evidence be: [How66] [DBL90], [Mat90], [ZQP93a], [HHM91], [HHM93], [JL94], [Eza94]

2.6.2 Fast Retraction of Evidence

How does result change if one (or more) item(s) of evidence is not included (related also to Sensitivity Analysis): [Daw92], [Jen95]

2.6.3 Sensitivity Analysis

How sensitive are answers to model probabilities: [Kor90], [HS93], [Las93], [CNKE93], [NK91], [NA91], [Pro91], [CS95] **Derivatives:** [Bun95a]

2.6.4 K-most probable cases

Compute the K most probable configurations, rather than just the single most probable one: [Hen90], [SG94], These find K -highly probable plans but no necessarily the K best: [KNL⁺93]

2.6.5 Generating Explanations

Explaining an inference: [Shi93], [LD93]

2.6.6 Other

Obtaining a simple description of the optimal policy in an Influence diagram: [LS93]

3 Learning/Acquiring Models

Survey: [Bun95a], [Hec95b]

3.1 Learning probabilities given structure:

(General purpose EM techniques not listed) [LPP95], [Mus93]

3.2 Learning structure

Bayesian Learning Approaches: [HGC94, HGC95], [HG95], [CGH94], [Hec95b], [Hec95a], [GH95a], [GH95b], [HB94a], [DL93b], [CH91b], [CH91a], [AC94], [Bad92], [Bun94], [CH92], [Coo95b], [Coo95a] [SDLC93] [Bou94], [Bun91], [Bun95b], [GH94b] **MDL:** [LB93], [Suz93] **Non-Bayesian Learning Approaches:** These usually involve statistical tests to find conditional independencies, followed by searches for good network encodings of these independencies. [PV91], [VP92], [SGS93], [SG91] [SV93], [FC90], [GPP93], [Chi95], [Mee95] **Acquiring Models from Experts:** [Mer90], [Hec93], [Jir90], [DvdG95] **Refinement of Existing Models:** [PH93], [CDS93], [OLJ92], [Las91]

4 Model-Based Knowledge Construction

Constructing a simplified problem-instance specific model from a larger and more general knowledge base: [BGW94], [WBG92], [Wel90a], [Bac93], [Poo93], [LL94], [SE94], [NB94], [Pro94], [PFH94], [Had94], [XPB92], [BGHK94], [Bre92], [NH95b, NH95a], [HHNK95, NHH95], [GC93, GC90] [DS94], [Pro93a], [GK95], Fusing Multiple Networks: [MA93], [Sha91]

5 Applications

Surveys: [HMW95] (and CACM March 1995 issue), [NO93], **Medical:** [BBQS92], [Coo84], [Hen90], [SEH90], [dBP90], [Spi87], [Spi90], [Hec89], [DG93b], [BBS91], [KRW+95], [Pro93a] **Monitoring (non-medical):** [HB95] **Tracking:** [KC90], [Fun88], [HKM+94] **High Risk Analysis:** [OY90], (Nuclear:)[PH90], **Troubleshooting:** [HBR94], [BH95] **Vision:** [JCJ93], [JCN92] **Classification:** [MC93], [PFH94] **Market Forecasting:** [Abr91], [DGH92] **Finance:** [ES95]

References

- [Abr91] Bruce Abramson. ARCO1: An application of belief networks to the oil market. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 1–8. Morgan Kaufmann, 1991.
- [AC94] C. Aliferis and Gregory Cooper. An evaluation of an algorithm for inductive learning of Bayesian belief networks using simulated data sets. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 8–14, Seattle, WA, 1994. Morgan Kauffman.
- [AFS94] Adriano Azevedo-Filho and Ross D. Shachter. Laplace’s method approximations for probabilistic inference in belief networks with continuous variables. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 28–36, Seattle, WA, 1994. Morgan Kauffman.
- [Ago91] John Mark Agosta. “Conditional inter-causally independent” node distributions, a property of “noisy-or” models. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 9–16. Morgan Kaufmann, 1991.
- [AHSE93] Heidi H. Andersen, Malene Højbjerg, Dorte Sørensen, and Poul S. Eriksen. Linear and graphical models for the multivariate complex normal distribution. Technical Report R-93-2010, Department of Mathematics and Computer Science, Aalborg University, Aalborg, Denmark, 1993.
- [AK93] R. Almond and Augustine Kong. Optimality issues in constructing a Markov tree from graphical models. *Journal of Computational and Graphical Statistics*, 1993.
- [AR90] A.M. Agogino and K. Ramamurthi. Real time influence diagrams for monitoring and controlling mechanical systems. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 9, pages 199–228. John Wiley & Sons, 1990.
- [Bac93] Fahiem Bacchus. Using first-order probability logic for the construction of Bayesian networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 219–226. Morgan Kaufmann, 1993.

- [Bad92] J. Badsberg. Model search in contingency tables by CoCo. *Computational Statistics*, pages 251–256, 1992.
- [Bal95] Alexander Balke. *Probabilistic Counterfactuals: Semantics, Computation and Applications*. PhD thesis, U.C.L.A. Computer Science Department, November 1995. Technical Report R-242.
- [BBQ89] C. Berzuni, R. Bellazzi, and S. Quaglini. Temporal reasoning with probabilities. In *Proceedings of the 1989 Workshop on Uncertainty in Artificial Intelligence*, pages 14–21. Association for Uncertainty in Artificial Intelligence, July 1989.
- [BBQS92] C. Berzuni, R. Bellazzi, S. Quaglini, and D. J. Spiegelhalter. Bayesian networks for patient monitoring. *Artificial Intelligence in Medicine*, 4(3):243–260, May 1992.
- [BBS91] Carlo Berzuni, Riccardo Bellazzi, and David Spiegelhalter. Bayesian networks applied to therapy monitoring. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 35–43. Morgan Kaufmann, 1991.
- [BF91] John S. Breese and Kenneth W. Fertig. Decision making with interval influence diagrams. *Uncertainty in Artificial Intelligence*, 6:467–478, 1991.
- [BG94] Ann Becker and Dan Geiger. Approximation algorithms for the loop cutset problem. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 60–68. Morgan Kauffman, 1994.
- [BG95] Fahiem Bacchus and Adam Grove. Graphical models for preference and utility. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [BGHK94] Fahiem Bacchus, Adam J. Grove, Joseph Y. Halpern, and Daphne Koller. Forming beliefs about a changing world. In *Proceedings of the Twelfth National Conference on Artificial Intelligence (AAAI)*, volume 1, pages 222–229. MIT Press, 1994.
- [BGW94] John S. Breese, Robert P. Goldman, and Michael P. Wellman. Introduction to the special section of knowledge-based construction of probabilistic and decision models. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(11):1577–1579, 1994.
- [BH95] John S. Breese and David Heckerman. Decision-theoretic case-based reasoning. Technical Report MSR-TR-95-03, Microsoft Research, Redmond, WA, January 1995. To appear in *Proceedings of the 5th International Workshop on Artificial Intelligence and Statistics 1995*.
- [BIS90] Richard E. Barlow, Telba Z. Irony, and S. W. W. Shor. Informative sampling methods: The influence of experimental design on decision. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 8, pages 177–197. John Wiley & Sons, 1990.
- [Bon87] Piero P. Bonissone. Summarizing and propagating uncertain information with triangular norms. *International Journal of Approximate Reasoning*, 1:71–101, 1987.
- [Bou94] Remco R. Bouckaert. Properties of Bayesian belief network learning algorithms. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, 1994.
- [BP94] Alexander Balke and Judea Pearl. Probabilistic evaluation of counterfactual queries. In *Proceedings of the Twelfth National Conference on Artificial Intelligence (AAAI)*, volume 1, pages 230–2237. MIT Press, 1994.
- [BP95] Alexander Balke and Judea Pearl. Counterfactuals and policy analysis in structural models. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [Bre92] John S. Breese. Construction of belief and decision networks. *Computational Intelligence*, 8(4):624–647, 1992.
- [Bun91] Wray Buntine. Theory refinement on Bayesian networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 52–60. Morgan Kaufmann, 1991.
- [Bun94] Wray Buntine. Operations for learning with graphical models. *Journal of Artificial Intelligence Research*, 2:159–225, 1994.
- [Bun95a] Wray Buntine. A guide to the literature on learning graphical models. Technical Report IC-95-05, NASA Ames Research Center, 1995.
- [Bun95b] Wray L. Buntine. Chain graphs for learning. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.

- [CBS95] Enrique F. Castillo, Remco R. Bouckaert, and José M. Sarabia. Estimation in approximate Bayesian belief network inference. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufman.
- [CC87] H. L. Chin and G. F. Cooper. Stochastic simulation of bayesian belief networks. In *Proceedings of Third Workshop on Uncertainty in AI*, pages 106–113, 1987.
- [CC90] R. Martin Chavez and Gregory F. Cooper. A randomized approximation algorithm for probabilistic inference in Bayesian belief networks. *Networks*, 20:661–685, 1990.
- [CDM91] José Cano, Miguel Delgado, and Serafín Moral. Propagation of uncertainty in dependence graphs. In R. Kruse and P. Siegel, editors, *Proceedings of the European Conference on Symbolic and Quantitative Approaches to Uncertainty (ECSQAU)*., pages 42–47, Marseille, France, October 1991. Springer-Verlag.
- [CDM93] José Cano, Miguel Delgado, and Serafín Moral. An axiomatic framework for propagating uncertainty in directed acyclic networks. *International Journal of Approximate Reasoning*, 8(4):253–280, 1993.
- [CDS93] R. G. Cowell, A. P. Dawid, and D. J. Spiegelhalter. Sequential model criticism in probabilistic expert systems. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):209–219, March 1993.
- [CF91] Kuo-Chu Chang and Robert Fung. Symbolic probabilistic inference with continuous variables. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 77–85. Morgan Kaufmann, 1991.
- [CGH94] David M. Chickering, Dan Geiger, and David Heckerman. Learning bayesian networks is NP-hard. Technical Report MSR-TR-94-17, Microsoft Research, Redmond, WA, November 1994.
- [CGH95] Enrique Castillo, José Manuel Gutierrez, and Ali S. Hadi. Parametric structure of probabilities in Bayesian networks. In *Proceedings of the European Conference on Symbolic and Quantitative Approaches to Reasoning and Uncertainty (ECSQARU)*, pages 89–98, Berlin, Germany, 1995. Springer-Verlag.
- [CH91a] Gregory Cooper and E. Herskovits. A Bayesian method for constructing bayesian belief networks from databases. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 86–94. Morgan Kaufmann, 1991.
- [CH91b] Gregory Cooper and E. Herskovits. A Bayesian method for the induction of probabilistic networks from data. Technical Report SMI-91-1, Dept. of Medical Informatics, Stanford University, January 1991.
- [CH92] Gregory Cooper and E. Herskovits. A Bayesian method for the induction of probabilistic networks from data. *Machine Learning*, 9:309–347, 1992.
- [Cha91] Eugene Charniak. Bayesian networks without tears. *AI Magazine*, 12(4):50–63, Winter 1991.
- [Chi95] David Maxwell Chickering. A transformational characterization of equivalent Bayesian network structures. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufman.
- [Chr96] Lonnie Chrisman. Propagation of 2-monotone lower probabilities (a.k.a. Choquet capacities) on an undirected graph. In *Proceedings of the 12th Conference on Uncertainty in Artificial Intelligence*, 1996.
- [CMVL93] José Cano, Serafín Moral, and J. F. Verdegay-Lopez. Propagation of convex sets of probabilities in directed acyclic graphs. In *Uncertainty in Intelligent Systems*, pages 15–26. North-Holland, 1993.
- [CNKE93] Peter Che, Richard E. Neapolitan, James Kenevan, and Martha Evens. An implementation of a method for computing the uncertainty in inferred probabilities in belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 292–300. Morgan Kaufmann, 1993.
- [Coo84] G.F. Cooper. *NESTOR: A Computer-Based Medical Diagnostic Aid that Integrates Causal and Probabilistic Knowledge*. PhD thesis, Computer Science Department, Stanford University, November 1984. STAN-CS-84-48.
- [Coo87] Gregory F. Cooper. Probabilistic inference using belief networks is NP-hard. Technical Report KSL-87-27, Medical Computer Science Group, Stanford University, 1987.
- [Coo90] Gregory F. Cooper. The computational complexity of probabilistic inference using belief networks. *Artificial Intelligence*, 42:393–405, 1990.
- [Coo95a] Gregory F. Cooper. A Bayesian method for learning belief networks that contain hidden variables. *Journal of Intelligent Information Systems*, 4:71–88, 1995.
- [Coo95b] Gregory F. Cooper. Causal discovery from data in the presence of selection bias. In *Fifth International Workshop on Artificial Intelligence and Statistics*, pages 140–150, Ft. Lauderdale, Florida, January 1995.

- [CS92] Brian Y. Chan and Ross D. Shachter. Structural controllability and observability in influence diagrams. In *Uncertainty in Artificial Intelligence: Proceedings of the Eighth Conference*, pages 25–32. Morgan Kaufmann, 1992.
- [CS95] Tom Chavez and Ross Shachter. Decision flexibility. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufmann.
- [D'A90] Bruce D'Ambrosio. Symbolic probabilistic inference in belief nets. In *Proceedings of the Eighth National Conference on Artificial Intelligence (AAAI)*, pages 126–131. MIT Press, 1990.
- [D'A91] Bruce D'Ambrosio. Local expression languages for probabilistic dependence: A preliminary report. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 95–102. Morgan Kaufmann, 1991.
- [D'A94] Bruce D'Ambrosio. Symbolic probabilistic inference in large BN20 networks. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 128–135, Seattle, WA, 1994. Morgan Kaufmann.
- [Dar94a] Adnan Darwiche. Dynamic conditioning: An efficient refinement of cutset conditioning using local and relevant cutsets. Technical Report Technical Memorandum 94-134, Rockwell Science Center, Palo Alto, California, 1994.
- [Dar94b] Adnan Darwiche. ϵ -bounded conditioning: An efficient refinement of cutset conditioning using local and relevant cutsets. Technical Report Technical Memorandum 94-135, Rockwell Science Center, Palo Alto, California, 1994.
- [Dar95] Adnan Darwiche. Conditioning methods for exact and approximate inference in causal networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufmann.
- [Daw79] A. P. Dawid. Conditional independence in statistical theory. *Journal Royal Statistical Society B*, 41(1):1–31, 1979.
- [Daw80] A. P. Dawid. Conditional independence for statistical operations. *Annals of Statistics*, 8:598–617, 1980.
- [Daw92] A. P. Dawid. Applications of a general propagation algorithm for probabilistic expert systems. *Statistics and Computing*, 2:25–36, 1992.
- [DBL90] Thomas Dean, Kenneth Basye, and Moises Lejter. Planning and active perception. In *Workshop on Innovative Approaches to Planning, Scheduling, and Control*, 1990.
- [dBP90] Carlos A. de B. Pereira. Influence diagrams and medical diagnosis. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 15, pages 351–358. John Wiley & Sons, 1990.
- [DC93] Paul Dagum and R. Martin Chavez. Approximating probabilistic inference in Bayesian belief networks. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):246–255, March 1993.
- [dCM95] Luis de Campos and Sarafín Moral. Independence concepts for convex sets of probabilities. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufmann.
- [DDP90] Rina Dechter, Avi Dechter, and Judea Pearl. Optimization in constraint networks. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 18, pages 411–425. John Wiley & Sons, 1990.
- [Dem90] A. P. Dempster. Construction and local computation aspects of network belief functions. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 6, pages 121–141. John Wiley & Sons, 1990.
- [DG93a] Paul Dagum and Adam Galper. Additive belief-network models. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 91–98. Morgan Kaufmann, 1993.
- [DG93b] Paul Dagum and Adam Galper. Forecasting sleep apnea with dynamic network models. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 64–71. Morgan Kaufmann, 1993.
- [DGH92] Paul Dagum, Adam Galper, and Eric Horvitz. Dynamic network models for forecasting. In *Proceedings of the 8th Conference on Uncertainty in Artificial Intelligence*, pages 41–48, 1992.
- [DGKP95] Arthur L. Delcher, Adam Grove, Simon Kasif, and Judea Pearl. Logarithmic-time updates and queries in probabilistic networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufmann.

- [DH92] Paul Dagum and Eric Horvitz. Reformulating inference problems through selective conditioning. In *Uncertainty in Artificial Intelligence: Proceedings of the Eighth Conference*, pages 49–54. Morgan Kaufmann, 1992.
- [DH93] Paul Dagum and Eric Horvitz. A Bayesian analysis of simulation algorithms for inference in belief networks. *Networks*, 23(5):499–516, August 1993.
- [DH94] Denise L. Draper and Steve Hanks. Localized partial evaluation of belief networks. In L. de Mantaras and D. Poole, editors, *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 170–177. Morgan Kaufmann, July 1994.
- [Die93] F. J. Diez. Parameter adjustment in Bayes networks. the generalized noisy OR-gate. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 99–105. Morgan Kaufmann, 1993.
- [Diar] F. J. Diez. Local conditioning in Bayesian networks. *Artificial Intelligence*, to appear.
- [DKL95] A. P. David, U. Kjoerulff, and S. L. Lauritzen. Hybrid propagation in junction trees. *Lecture Notes in Computer Science*, 945:87–??, 1995.
- [DL93a] Paul Dagum and Michael Luby. Approximating probabilistic inference in Bayesian belief networks is NP-hard. *Artificial Intelligence*, 60(1):141–153, March 1993.
- [DL93b] A. P. Dawid and S. L. Lauritzen. Hyper Markov laws in the statistical analysis of decomposable graphical models. *The Annals of Statistics*, 21(3), September 1993.
- [DLS80] J. N. Darroch, S. L. Lauritzen, and T. P. Speed. Markov fields and log-linear interaction models for contingency tables. *Annals of Statistics*, 8:522–539, 1980.
- [DM95] Eric Driver and Darryl Morrell. Implementation of continuous Bayesian networks using sums of weighted Gaussians. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [Dra95] Denise L. Draper. Clustering without (thinking about) triangulation. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [DS93] Marek J. Druzdzel and Herbert A. Simon. Causality in bayesian belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 3–11. Morgan Kaufmann, 1993.
- [DS94] Marek J. Druzdzel and Henri J. Suermondt. Relevance in probabilistic models: “backyards” in a “small world”. In *Working notes of the AAAI-1994 Fall Symposium Series: Relevance*, pages 60–63, New Orleans, Louisiana, November 1994.
- [DvdG95] Marek Druzdzel and Linda C. van der Gaag. Elicitation of probabilities for belief networks: Combining qualitative and quantitative information. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [ES95] Kazuo J. Ezawa and Til Schuermann. Fraud/uncollectible debt detection using a Bayesian network based learning system: A rare binary outcome with mixed data structures. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [Eza94] Kazuo J. Ezawa. Value of evidence on influence diagrams. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 212–220, Seattle, WA, 1994. Morgan Kauffman.
- [FB93] Kenneth W. Fertig and John S. Breese. Probability intervals over influence diagrams. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):280–286, March 1993.
- [FC89] R. Fung and K. C. Chang. Weighting and integrating evidence for stochastic simulation in Bayesian networks. In *Proceedings of the Fifth Conference on Uncertainty in Artificial Intelligence*, Windsor, Ontario, 1989. Morgan Kauffman.
- [FC90] R.M. Fung and S.L. Crawford. Constructor: A system for the induction of probabilistic models. In *Proceedings of the Eighth National Conference on Artificial Intelligence (AAAI)*, pages 762–769, Boston, 1990. MIT Press.
- [FDF94] Robert Fung and Brendan Del Favero. Backward simulation in Bayesian networks. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 227–234, Seattle, WA, 1994. Morgan Kauffman.
- [Fry90] Morten Frydenberg. The chain graph Markov property. *Scandinavian Journal of Statistics*, 17:333–353, 1990.
- [Fun88] R. Fung. *Structure Composing for Situation Assessment*. PhD thesis, Engineering Economic Systems, Stanford University, 1988.

- [GC90] Robert P. Goldman and Eugene Charniak. Dynamic construction of belief networks. In *Proceedings of the Sixth Conference on Uncertainty in Artificial Intelligence*, pages 90–97, Cambridge, July 1990.
- [GC93] Robert P. Goldman and Eugene Charniak. A language for construction of belief networks. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):196–208, March 1993.
- [GD95] Moisés Goldszmidt and Adnan Darwiche. Plan simulation using Bayesian networks. In *Proceedings of the Eleventh Conference on Artificial Intelligence for Applications (IEEE-CAIA)*, pages 155–161, 1995.
- [GG84] S. Geman and D. Geman. Stochastic relaxation, Gibbs distributions, and the Bayesian restoration of images. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 6:721–741, 1984.
- [GH91] Dan Geiger and David Heckerman. Advances in probabilistic reasoning. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 118–126. Morgan Kaufmann, 1991.
- [GH93] Dan Geiger and David Heckerman. Inference algorithms for similarity networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 326–334. Morgan Kaufmann, 1993.
- [GH94a] Dan Geiger and David Heckerman. A characterization of the Dirichlet distribution through global and local independence. Technical Report MSR-TR-94-16, Microsoft Research, Redmond, WA, 1994. Revised Feb 1995.
- [GH94b] Dan Geiger and David Heckerman. Learning Gaussian networks. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 235–243, Seattle, WA, 1994. Morgan Kauffman.
- [GH95a] Dan Geiger and David Heckerman. A characterization of the Dirichlet distribution with application to learning Bayesian networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [GH95b] Dan Geiger and David Heckerman. Learning Bayesian networks: A unification for discrete and Gaussian domains. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [GK95] Sabine Glesner and Daphne Koller. Constructing flexible dynamic belief networks from first-order probabilistic knowledge bases. In *Proceedings of the European Conference on Symbolic and Quantitative Approaches to Reasoning and Uncertainty (ECSQARU-95)*, Fribourg, Switzerland, July 1995.
- [Gol90] Michael Goldsten. Influence and belief adjustment. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 7, pages 143–174. John Wiley & Sons, 1990.
- [GP88] Dan Geiger and Judea Pearl. Logical and algorithmic properties of conditional independence. Technical Report R-97, Cognitive Systems Laboratory, U.C.L.A., 1988.
- [GP95] David Galles and Judea Pearl. Testing identifiability of causal effects. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [GP96] D. Galles and Judea Pearl. Axioms of causal relevance. In *Proceedings of the Fourth International Conference on Mathematics and Artificial Intelligence*, pages 64–67, Fort Lauderdale, Florida, January 1996. Also available as U.C.L.A. Computer Science Technical Report R-240.
- [GPP93] Dan Geiger, A. Paz, and Judea Pearl. Learning simple causal structures. *International Journal of Intelligent Systems*, 8(2):231–247, February 1993.
- [GVP90] Dan Geiger, Thomas Verma, and Judea Pearl. Identifying independence in Bayesian networks. *Networks*, 20:507–534, 1990.
- [Had94] Peter Haddawy. Generating Bayesian networks from probability logic knowledge bases. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, 1994.
- [HB94a] David Heckerman and John S. Breese. Causal independence for belief-network knowledge acquisition and inference. Technical Report MSR-TR-94-08, Microsoft Research, Redmond, WA, August 1994.
- [HB94b] David Heckerman and John S. Breese. A new look at causal independence. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 286–292, Seattle, WA, 1994. Morgan Kauffman.
- [HB95] Eric Horvitz and Matthew Barry. Display of information for time-critical decision making. In *Proceedings of the Eleventh Conference on Uncertainty in Artificial Intelligence*, pages 296–305, Montreal, 1995. Morgan Kauffman.
- [HBH88] Eric J. Horvitz, John S. Breese, , and Max Henrion. Decision theory in expert systems and artificial intelligence. *International Journal of Approximate Reasoning*, 2:247–302, 1988.

- [HBH91] Max Henrion, John S. Breese, and Eric J. Horvitz. Decision analysis and expert systems. *AI Magazine*, 1991. Or see [HBH88].
- [HBR94] David Heckerman, John S. Breese, and Koos Rommelse. Troubleshooting under uncertainty. In *Proceedings of the Fifth International Workshop on Principles of Diagnosis*, New Paltz, NY, 1994. To appear. Avail. as Microsoft Research Tech Report MSR-TR-94-07.
- [Hec89] David Heckerman. A tractable algorithm for diagnosing multiple diseases. In *Proceedings of the Fifth Workshop on Uncertainty in Artificial Intelligence*, pages 174–181, 1989. Also in M. Henrion, R. Shachter, L. Kanal, and J. Lemmer, editors, *Uncertainty in Artificial Intelligence 5*, pages 163–171, North-Holland, 1990.
- [Hec90a] David Heckerman. Probabilistic similarity networks. Technical Report STAN-CS-1316, Depts. of Computer Science and Medicine, Stanford Univ., 1990.
- [Hec90b] David Heckerman. A tractable algorithm for diagnosing multiple diseases. In *Uncertainty in Artificial Intelligence 5*, pages 163–171. Elsevier, Amsterdam, 1990.
- [Hec93] David Heckerman. Causal independence for knowledge acquisition and inference. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 122–127. Morgan Kaufmann, 1993.
- [Hec95a] David Heckerman. A Bayesian approach to learning causal networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kaufman.
- [Hec95b] David Heckerman. A tutorial on learning bayesian networks. Technical Report MSR-TR-95-06, Microsoft Research, Redmond, WA, March 1995.
- [Hen88] Max Henrion. Propagation of uncertainty by Bayesian networks by probabilistic logic sampling. In J. F. Lemmer and L. N. Kanal, editors, *Uncertainty in Artificial Intelligence 2*, pages 149–163. Elsevier/North-Holland, Amsterdam, London, New York, 1988.
- [Hen90] Max Henrion. Towards efficient probabilistic diagnosis in multiply connected belief networks. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 17, pages 385–409. John Wiley & Sons, 1990.
- [Hen91] Max Henrion. Search-based methods to bound diagnostic probabilities in very large belief nets. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 142–150. Morgan Kaufmann, 1991.
- [HG95] David Heckerman and Dan Geiger. Learning bayesian networks. Technical Report MSR-TR-95-02, Microsoft Research, Redmond, WA, February 1995.
- [HGC94] David Heckerman, Dan Geiger, and David M. Chickering. Learning Bayesian networks: The combination of knowledge and statistical data. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 293–301, Seattle, WA, 1994. Morgan Kauffman.
- [HGC95] David Heckerman, Dan Geiger, and David M. Chickering. Learning Bayesian networks: The combination of knowledge and statistical data. *Machine Learning*, 1995. To Appear. Also avail. as Microsoft Tech Report MSR-TR-94-09.
- [HH88] David E. Heckerman and Eric J. Horvitz. The myth of modularity in rule-based systems for reasoning with uncertainty. In J. F. Lemmer and L. N. Kanal, editors, *Uncertainty in Artificial Intelligence*, volume 2, pages 23–34. Elsevier Science Publishers B.V., North-Holland, 1988.
- [HHM91] David Heckerman, Eric Horvitz, and Blackford Middleton. An approximate nonmyopic computation for value of information. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 135–141. Morgan Kaufmann, 1991.
- [HHM93] David Heckerman, Eric Horvitz, and Blackford Middleton. An approximate nonmyopic computation for value of information. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):292–298, March 1993.
- [HHNK95] Peter Haddawy, James W. Helwig, Liem Ngo, and Robert A. Krieger. Clinical simulation using context-sensitive temporal probability models. In *Proceedings of the 19th Annual Symposium on Computer Applications in Medical Care (SCAMC95)*, 1995.
- [HKM⁺94] T. Huang, D. Koller, J. Malik, G. Ogasawara, B. Rao, S. Russell, and J. Weber. Automatic symbolic traffic scene analysis using belief networks. In *Proceedings of the Twelfth National Conference on Artificial Intelligence (AAAI)*, volume 2, pages 966–972, Seattle, WA, 1994. MIT Press.

- [HM84] Ronald A. Howard and J. E. Matheson. Influence diagrams. In R. A. Howard and J. E. Matheson, editors, *Principles and Applications of Decision Analysis*, chapter 2. Strategic Decisions Group, Menlo Park, Ca, 1984.
- [HMW95] David Heckerman, A. Mamdani, and Michael Wellman. Real-world applications of Bayesian networks. *Communications of the ACM*, 38, 1995.
- [How66] Ronald A. Howard. Information value theory. *IEEE Transactions on Systems Science and Cybernetics*, SSC-2(1), August 1966.
- [How90] Ronald A. Howard. From influence to relevance to knowledge. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 1, pages 3–23. John Wiley & Sons, 1990.
- [Hry90] Tomas Hrycej. Gibbs sampling in Bayesian networks. *Artificial Intelligence*, 46(3):351–363, December 1990.
- [HS93] David Heckerman and Michael Shwe. Diagnosis of multiple faults: A sensitivity analysis. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 80–87. Morgan Kaufmann, 1993.
- [HS94] David Heckerman and R. Shachter. A decision-based view of causality. In *Proceedings of Tenth Conference on Uncertainty in Artificial Intelligence*, pages 302–310. Morgan Kaufmann, 1994.
- [HT87] T. J. Hastie and R. J. Tibshirani. Generalized additive models: Some applications. *Journal of the American Statistical Association*, 82:371–386, 1987.
- [Ish81] V. Isham. An introduction to spatial point processes and Markov random fields. *International Statistics Review*, 49:21–43, 1981.
- [JA90] Frank Jensen and Stig Kjaer Andersen. Approximations in Bayesian belief universes for knowledge-based systems. In *Proceedings of the Sixth Conference on Uncertainty in Artificial Intelligence*, 1990.
- [JCJ93] Liang Jian-Ming, Henrik I. Christensen, and Finn V. Jensen. Qualitative recognition using Bayesian reasoning. Aalborg University, November 1993.
- [JCN92] Finn Verner Jensen, Henrik I. Christensen, and Jan Nielsen. Bayesian methods for interpretation and control in multi-agent vision systems. In *Applications of Artificial Intelligence X: Machine Vision and Robotics, SPIE Proceedings Serie, Vol. 1708*, 1992.
- [Jen93] F. V. Jensen. Introduction to Bayesian networks. Technical Report IR-93-2003, Dept. of Mathematics and Computer Science, Aalborg University, Aalborg, Denmark, 1993.
- [Jen94] Frank Jensen. Implementation aspects of various propagation algorithms in Hugin. Technical Report R 94-2014, Aalborg University, Denmark, March 1994.
- [Jen95] F. V. Jensen. Cautious propagation in Bayesian networks. In *Proceedings of the Eleventh Conference on Uncertainty in Artificial Intelligence*, Montreal, 1995.
- [Jir90] R. Jirousek. A survey of methods used in probabilistic expert systems for knowledge integration. *Knowledge-Based Systems*, 3(1):7–12, March 1990.
- [Jir94] R. Jirousek. Decision-tree modelling of probability distributions. *International Journal of General Systems*, 22(2):125–137, 1994.
- [JJ94] Finn V. Jensen and Frank Jensen. Optimal junction trees. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, 1994.
- [JJD94] Frank Jensen, Finn V. Jensen, and Søren L. Dittmer. From influence diagrams to junction trees. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, July 1994.
- [JKK93] Claus Skaanning Jensen, Augustin Kong, and Uffe Kjaerulff. Blocking gibbs sampling in very large probabilistic expert systems. Technical Report R 93-2031, Aalborg University, Denmark, 1993.
- [JKK95] Claus Skaanning Jensen, Uffe Kjaerulff, and Augustin Kong. Blocking gibbs sampling in very large probabilistic expert systems. *International Journal of Human-Computer Studies*, 42(6):647–666, June 1995.
- [JL94] F. V. Jensen and J. Liang. drHugin — a system for value of information in Bayesian networks. In *Proceedings of the Fifth International Conference on Information Processing and Management of Uncertainty in Knowledge-Based Systems*, 1994.
- [JLO90] Finn V. Jensen, Steffen L. Lauritzen, and Kristian G. Olesen. Bayesian updating in causal probabilistic networks by local computations. *Computational Statistics Quarterly*, 4:269–282, 1990.

- [JOA90] Finn Verner Jensen, Kristian G. Olesen, and Stig Kjaer Andersen. An algebra of Bayesian belief universes for knowledge-based systems. *Networks*, 20:637–659, 1990.
- [KC90] C. Robert Kenley and Thomas R. Casaletto. Multi-target tracking using influence diagram models. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 10, pages 229–251. John Wiley & Sons, 1990.
- [KD89] Keiji Kanazawa and Thomas Dean. A model for projection and action. In *Eleventh International Joint Conference on Artificial Intelligence (IJCAI)*, pages 985–990, 1989.
- [Ken86] C. Robert Kenley. Influence diagram models with continuous variables. Technical Report LMSC-DO67192, Astronautics Division, Lockheed Missiles and Space Company, Sunnyvale, CA, June 1986.
- [Kja92] Uffe Kjaerulff. A computational scheme for reasoning in dynamic probabilistic networks. In *Proceedings of the Eighth Conference on Uncertainty in Artificial Intelligence*, pages 121–129, San Mateo, Calif., 1992. Morgan Kaufmann.
- [Kja93] Uffe Kjaerulff. Approximation of bayesian networks through edge removals. Technical Report IR-93-2007, Institute for Electronic Systems, Department of Mathematics and Computer Science, Aalborg, Denmark, August 1993.
- [Kja94] Uffe Kjaerulff. Reduction of computational complexity in bayesian networks through the removal of weak dependences. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, San Mateo, Calif., 1994. Morgan Kaufmann.
- [Kja95a] Uffe Kjaerulff. dHugin: A computational system for dynamic time-sliced bayesian networks. *International Journal of Forecasting*, 1995.
- [Kja95b] Uffe Kjaerulff. HUGS: Combining exact inference and Gibbs sampling in junction trees. In *Proceedings of the Eleventh Conference on Uncertainty in Artificial Intelligence*, Montreal, 1995.
- [KKR95] Keiji Kanazawa, Daphne Koller, and Stuart Russell. Stochastic simulation algorithms for dynamic probabilistic networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [KNL⁺93] Jak Kirman, Ann Nicholson, Moises Lejter, Thomas Dean, and Eugene Santos, Jr. Using goals to find plans with high expected utility. In *Second European Workshop on Planning (EWSP)*, 1993.
- [Kon86] A. Kong. *Multivariate belief functions and graphical models*. PhD thesis, Department of Statistics, Harvard University, 1986.
- [Kor90] Robert James Korsan. Towards better assessment and sensitivity procedures. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 19, pages 427–455. John Wiley & Sons, 1990.
- [KP83] J. H. Kim and Judea Pearl. A computational model for combined causal and diagnostic reasoning in inference systems. In *Proceedings of the Eighth International Joint Conference on Artificial Intelligence (IJCAI)*, pages 190–193, Los Angeles, 1983.
- [KRW⁺95] Charles E. Kahn, Jr., Linda M. Roberts, Kun Wang, Deb Jenks, and Peter Haddawy. Preliminary investigation of a Bayesian network for Mammographic diagnosis of breast cancer. In *Proceedings of SCAMC95*, October 1995.
- [KS95] Alexander V. Kozlov and Jaswinder Pal Singh. Sensitivities: An alternative to conditional probabilities for Bayesian belief networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [KSC84] Harri Kuiveri, Terry P. Speed, and J.B. Carlin. Recursive causal models. *Journal of the Australian Mathematical Society A*, 36:30–52, 1984.
- [KV95] Young-Gyun Kim and Marco Valtorta. On the detection of conflicts in diagnostic Bayesian networks using abstraction. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [Lam94] Wai Lam. Abstraction in Bayesian belief networks and automatic discovery from past inference sessions. In *Proceedings of the Twelfth National Conference on Artificial Intelligence (AAAI)*, volume 1, pages 257–262. MIT Press, 1994.
- [Las91] Kathrun Blackmond Laskey. Conflict and surprise: Heuristics for model revision. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 197–204. Morgan Kaufmann, 1991.

- [Las93] Kathryn Blackmond Laskey. Sensitivity analysis for probability assessments in Bayesian networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 136–142. Morgan Kaufmann, 1993.
- [Lau82] S. L. Lauritzen. *Lectures on Contingency Tables*. University of Aalborg Press, Denmark, 2nd ed. edition, 1982.
- [Lau92] Steffen L. Lauritzen. Propagation of probabilities, means and variances in mixed graphical association models. *Journal of the American Statistical Association*, 87(420):1098–1108, December 1992.
- [LB93] Wai Lam and Fahiem Bacchus. Using causal information and local measures to learn Bayesian networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 243–250. Morgan Kaufmann, 1993.
- [LD93] Zhaoyu Li and Bruce D’Ambrosio. An efficient approach for finding the MPE in belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 342–349. Morgan Kaufmann, 1993.
- [LD94] Zhaoyu Li and B. D’Ambrosio. Efficient inference in bayes networks as a combinatorial optimization problem. *International Journal of Approximate Reasoning*, 11(1):55–81, July 1994.
- [LL94] Kathryn Blackmond Laskey and Paul E. Lehner. Metareasoning and the problem of small worlds. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(11):1643–1652, November 1994.
- [LPP95] John Lafferty, Stephen Della Pietra, and Vincent Della Pietra. Inducing features of random fields. Technical Report CMU-CS-94-229, School of Computer Science, Carnegie Mellon University, Pittsburgh, PA, January 1995.
- [LS88] Steffen L. Lauritzen and David J. Spiegelhalter. Local computations with probabilities on graphical structures and their applications to expert systems. *Journal Royal Statistical Society, Series B*, 50(2):157–224, 1988. Reprinted in [SP90, Pages 415–448].
- [LS93] Paul E. Lehner and Azar Sadigh. Two procedures for compiling influence diagrams. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 335–341. Morgan Kaufmann, 1993.
- [LSV84] S. L. Lauritzen, T. P. Speed, and K. Vijayan. Decomposable graphs and hypergraphs. *Journal of the Australian Mathematical Society (Series A)*, 36:12–29, 1984.
- [LW89] S. L. Lauritzen and N. Wermuth. Graphical models for associations between variables, some of which are qualitative and some quantitative. *The Annals of Statistics*, 17(1):31–57, 1989.
- [MA93] Izhar Matzkevich and Bruce Abramson. Some complexity considerations in the combination of belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 152–158. Morgan Kaufmann, 1993.
- [Mat90] James E. Matheson. Using influence diagrams to value information and control. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 2, pages 25–48. John Wiley & Sons, 1990.
- [MC93] S. A. Musman and L. W. Chang. A study of scaling issues in Bayesian belief networks for ship classification. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 32–39. Morgan Kaufmann, 1993.
- [MC96] Stefano Monti and Gregory F. Cooper. Bounded recursive decomposition: A search-based method for belief network inference under limited resources. *International Journal of Approximate Reasoning*, 1996. to appear.
- [MD90] Max Menrion and Marek Druzdzal. Qualitative propagation and scenario-based approaches to explanation of probabilistic reasoning. In *Proceedings of the sixth Conference on Uncertainty in Artificial Intelligence*, pages 10–20, 1990.
- [Mee95] Christopher Meek. Relating graphical frameworks: Undirected, directed acyclic and chain graph models. Technical Report CMU-PHIL-64, Dept. Philosophy, Carnegie Mellon University, 1995.
- [Mel87] K. Mellouli. *On the Propagation of Beliefs in Networks using the Dempster-Shafer Theory of Evidence*. PhD thesis, School of Business, University of Kansas, 1987.
- [Mer90] Miley W. Merkhofer. Using influence diagrams in multiattribute utility analysis — improving effectiveness through improving communication. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 13, pages 297–317. John Wiley & Sons, 1990.

- [Mus93] Ron Musick. Minimal assumption distribution propagation in belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 251–258. Morgan Kaufmann, 1993.
- [MW94] Saraffn Moral and Nic Wilson. Markov chain Monte-Carlo algorithms for the calculation of Dempster-Shafer belief. In *Proceedings of the Twelfth National Conference on Artificial Intelligence*, pages 269–274, Seattle, Washington, 1994.
- [NA91] Keung-Chi Ng and Bruce Abramson. A sensitivity analysis of Pathfinder: A follow-up study. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 242–248. Morgan Kaufmann, 1991.
- [NB92] Ann E. Nicholson and J. Michael Brady. Sensor validation using dynamic belief networks. In *Proceedings of the 8th Conference on Uncertainty in Artificial Intelligence*, pages 207–214, 1992.
- [NB94] Ann E. Nicholson and J. Michael Brady. Dynamic belief networks for discrete monitoring. *IEEE Transactions on Systems, Man and Cybernetics*, 24(11):1593–1610, November 1994.
- [Ndi94] P. Ndilikikiesha. Potential influence diagrams. *International Journal of Approximate Reasoning*, 10(3), 1994.
- [Nea93] Radford M. Neal. Probabilistic inference using Markov chain Monte Carlo methods. Technical Report CRG-TR-93-1, Dept. of Computer Science, University of Toronto, 1993.
- [NH95a] Liem Ngo and Peter Haddawy. Answering queries from context-sensitive probabilistic knowledge bases. *Theoretical Computer Science: Special Issue on Uncertainty in Databases and Deductive Systems*, 1995. To Appear.
- [NH95b] Liem Ngo and Peter Haddawy. Probabilistic logic programming and Bayesian networks. In *Proceedings of the Asian Computing Science Conference*, Pathumthani, Thailand, December 1995.
- [NHH95] Liem Ngo, Peter Haddawy, and James Helwig. A theoretical framework for context-sensitive temporal probability model construction with application to plan projection. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, pages 419–426, Montreal, August 1995. Morgan Kauffman.
- [NK91] Richard E. Neapolitan and James R. Kenevan. Bayesian networks applied to therapy monitoring. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 232–241. Morgan Kaufmann, 1991.
- [NO93] M. Noormohammadian and U. G. Opper. Examples of causal probabilistic expert systems. In *Symbolic and Quantitative Approaches to Reasoning and Uncertainty. European Conference ECSQARU Proceedings.*, pages 290–295, Berlin, Germany, 1993. Springer-Verlag.
- [OL92] R. Orre and A. Lansner. A bayesian network for temporal segmentation. In *Proceedings of the International Conference on Artificial Neural Networks (ICANN)*, pages 1081–1084, Amsterdam, Netherlands, September 1992. Elsevier.
- [Ole93] Kristian G. Olesen. Causal probabilistic networks with both discrete and continuous variables. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 3(15):275–279, 1993.
- [OLJ92] Kristian G. Olesen, Steffen L. Lauritzen, and Finn V. Jensen. aHUGIN: A system creating adaptive causal probabilistic networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Eighth Conference*, pages 223–229. Morgan Kaufmann, 1992.
- [OY90] Robert M. Oliver and H. J. Yang. Bayesian updating of event tree parameters to predict high risk incidents. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 12, pages 277–296. John Wiley & Sons, 1990.
- [Par95] Simon Parsons. Refining reasoning in qualitative probabilistic networks. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [PD96] Judea Pearl and Rina Dechter. Identifying independencies in causal graphs with feedback. Technical Report R-243, U.C.L.A. Computer Science Department, March 1996. Submitted to UAI-96.
- [Pea86a] Judea Pearl. A constraint-propagation approach to probabilistic reasoning. In L. N. Kanal and J. F. Lemmer, editors, *Uncertainty in Artificial Intelligence*, pages 357–370. North Holland, Amsterdam, 1986.
- [Pea86b] Judea Pearl. Fusion, propagation and structuring in belief networks. *Artificial Intelligence*, 29(3):241–288, 1986.
- [Pea87a] Judea Pearl. Bayesian decision methods. In *Encyclopedia of A.I.* Wiley Interscience, 1987.

- [Pea87b] Judea Pearl. Evidential reasoning using stochastic simulation of causal models. *Artificial Intelligence*, 32(2):245–257, 1987.
- [Pea88a] Judea Pearl. Embracing causality in formal reasoning. *Artificial Intelligence*, 35(2):259–271, 1988.
- [Pea88b] Judea Pearl. *Probabilistic Reasoning in Intelligent Systems: Networks of Plausible Inference*. Morgan Kaufmann, San Mateo, CA, 1988.
- [Pea93] Judea Pearl. Belief networks revisited. *Artificial Intelligence*, 59(1–2):49–56, February 1993.
- [Pea94a] Judea Pearl. On the identification of nonparametric structural equations. Technical Report R-207, U.C.L.A., March 1994.
- [Pea94b] Judea Pearl. Three statistical puzzles. Technical Report R-217, U.C.L.A., February 1994.
- [Pea95a] Judea Pearl. Causal diagrams for empirical research. *Biometrika*, 82(4):669–709, December 1995.
- [Pea95b] Judea Pearl. Causal inference from indirect experiments. *Artificial Intelligence in Medicine Journal*, 7(6):561–582, 1995.
- [Pea96] Judea Pearl. Structural and probabilistic causality. In D.R. Shanks, K.J. Holyoak, and D.L. Medin, editors, *The Psychology of Learning and Motivation*, volume 34. Academic Press, San Diego, 1996. Also available as U.C.L.A. Computer Science Technical Report R-237, November 1995.
- [PFH94] Kim Leng Poh, Michael R. Fehling, and Eric J. Horvitz. Dynamic construction and refinement of utility-based categorization models. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(11):1653–1663, November 1994.
- [PGV90] Judea Pearl, Dan Geiger, and Thomas Verma. The logic of influence diagrams. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 4, pages 67–87. John Wiley & Sons, 1990.
- [PH90] Lawrence D. Phillips and Patrick Humphreys. A socio-technical approach to assessing human reliability. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 11, pages 253–276. John Wiley & Sons, 1990.
- [PH93] Kim Leng Poh and Eric J. Horvitz. Reasoning about the value of decision-model refinement: Method nad application. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 174–182. Morgan Kaufmann, 1993.
- [PM93] Simon Parsons and E. H. Mamdami. On reasoning in networks with qualitative uncertainty. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 435–442. Morgan Kaufmann, 1993.
- [Poo93] David Poole. The use of conflicts in searching Bayesian networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 359–367. Morgan Kaufmann, 1993.
- [PP85] Judea Pearl and A. Paz. GRAPHOIDS: A graph-based logic for reasoning about relevance relations. Technical Report 850038 (R-53-L), Cognitive Systems Laboratory, U.C.L.A., 1985.
- [PR86] Y. Peng and J. A. Reggia. Plausibility of diagnostic hypotheses. In *Proceedings of the 5th National Conference on Artificial Intelligence (AAAI)*, pages 140–145, 1986.
- [Pro91] G.M.A. Provan. Dynamic network updating techniques for diagnostic reasoning. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 279–286. Morgan Kaufmann, 1991.
- [Pro93a] Gregory M. Provan. Dynamic network construction and updating techniques for the diagnosis of acute abdominal pain. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 15(3):299–307, March 1993.
- [Pro93b] Gregory M. Provan. Tradeoffs in constructing and evaluating temporal influence diagrams. In *Proceedings of the 9th Conference on Uncertainty in Artificial Intelligence*, pages 40–47, 1993.
- [Pro94] Gregory M. Provan. Tradeoffs in knowledge-based construction of probabilistic models. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(11):1580–1592, November 1994.
- [PS91] Mark A. Peot and Ross D. Shachter. Fusion and propagation with multiple observations in belief networks. *Artificial Intelligence*, 48(3):299–318, 1991.
- [PV87] Judea Pearl and Thomas S. Verma. The logic of representing dependencies by directed graphs. In *Proceedings of the Sixth National Conference on AI (AAAI)*, pages 347–379, Seattle, 1987.
- [PV91] Judea Pearl and Thomas S. Verma. A theory of inferred causation. In J. Allen, R. Fikes, and E. Sandewall, editors, *Knowledge Representation and Reasoning: Proceedings of the Second International Conference*, pages 441–452, New York, 1991. Morgan Kaufmann.

- [RK93] Carlos Rojas-Guzmán and Mark A. Kramer. GALGO: A genetic ALGOritm decision support tool for complex uncertain systems modeled with Bayesian belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 368–375. Morgan Kaufmann, 1993.
- [Ros75] A. Rosenthal. A computer scientist looks at reliability computations. In Barlow, Fussell, and Singpurwalla, editors, *Reliability and Fault Tree Analysis*, pages 133–152. SIAM, Philadelphia, 1975.
- [San94] Eugene Santos, Jr. A linear constraint satisfaction approach to cost-based abduction. *Artificial Intelligence*, 65(1):1–28, 1994.
- [Sar93] Sumit Sarkar. Using tree-decomposable structures to approximate belief networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 376–382. Morgan Kaufmann, 1993.
- [SAS94] Ross D. Shachter, Stig K. Anderson, and Peter Szolovits. Global conditioning for probabilistic inference in belief networks. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, pages 514–522, 1994.
- [SC90] H. Jacques Suermondt and Gregory F. Cooper. Probabilistic inference in multiply connected networks using loop cutsets. *International Journal of Approximate Reasoning*, 4:283–306, 1990.
- [SDD90] Ross D. Shachter, Bruce D’Ambrosio, and Brendan A. Del Favero. Symbolic probabilistic inference in belief networks. In *Proceedings of the Eighth National Conference on Artificial Intelligence*, pages 126–131. MIT Press, 1990.
- [SDLC93] David Spiegelhalter, A. Dawid, S. Lauritzen, and R. Cowell. Bayesian analysis in expert systems. *Statistical Science*, 8:219–282, 1993.
- [SE91] Alessandro Saffiotti and Elisabeth Emkehrer. PULCINELLA: A general tool for propagating uncertainty in valuation networks. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 232–331. Morgan Kaufmann, 1991.
- [SE94] Alessandro Saffiotti and Elisabeth Emkehrer. Inference-driven construction of valuation systems from first-order clauses. *IEEE Transactions on Systems, Man, and Cybernetics*, 24(11):1611–1624, November 1994.
- [SEH90] Ross D. Shachter, David M. Eddy, and Victor Hasselblad. An influence diagram approach to medical technology assessment. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 14, pages 321–350. John Wiley & Sons, 1990.
- [SG91] Peter Spirtes and Clark Glymour. An algorithm for fast recovery of sparse causal graphs. *Social Science Computing Review*, 9(1):62–72, 1991.
- [SG94] B. Seroussi and J. L. Golmard. An algorithm directly finding the k most probable configurations in Bayesian networks. *International Journal of Approximate Reasoning*, 11(3):205–233, October 1994.
- [SGS93] Peter Spirtes, Clark Glymour, and R. Scheines. *Causation, Prediction and Search*. Springer-Verlag, New York, 1993.
- [Sha86] Ross D. Shachter. Evaluating influence diagrams. *Operations Research*, 33(6), 1986.
- [Sha90] Ross D. Shachter. Evidence absorption and propagation through evidence reversals. In M. Henrion, R. D. Shachter, L. N. Kanal, and J. F. Lemmer, editors, *Uncertainty in Artificial Intelligence 5*, pages 173–190. Elsevier Science, Amsterdam, 1990.
- [Sha91] Ross D. Shachter. A graph-based inference method for conditional independence. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 353–360. Morgan Kaufmann, 1991.
- [She92] Prakash P. Shenoy. Valuation-based systems for Bayesian decision analysis. *Operations Research*, 40(3):463–484, 1992.
- [She93] Prakash P. Shenoy. Valuation networks and conditional independence. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 191–199. Morgan Kaufmann, 1993.
- [Shi93] Solomon Eyal Shimony. Relevant explanations: Allowing disjunctive assignments. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 200–207. Morgan Kaufmann, 1993.
- [Shi94] Solomon Eyal Shimony. Finding MAPs for belief networks is NP-hard. *Artificial Intelligence*, 68(2):399–410, August 1994.
- [SHJ96] Padhraic Smyth, David Heckerman, and Michael Jordan. Probabilistic independence networks for hidden Markov probability models. Technical Report A.I. Memo No. 1565, C.B.C.L. Memo No. 132, M.I.T., February 1996.

- [SJ95] Lawrence K. Saul and Michael I. Jordan. Exploiting tractable substructures in intractable networks. In *Advances of Neural Information Processing Systems: Proceedings of the 1995 Conference*, 1995.
- [SJJ96] Lawrence K. Saul, Tommi Jaakkola, and Michael I. Jordan. Mean field theory for sigmoid belief networks. *Journal of Artificial Intelligence Research*, 4:61–76, March 1996.
- [SK89] Ross D. Shachter and C. Robert Kenley. Gaussian influence diagrams. *Management Science*, 35(5):527–550, 1989.
- [SL90] David J. Spiegelhalter and Steffen L. Lauritzen. Sequential updating of conditional probabilities on directed graphical structures. *Networks*, 20:579–605, 1990.
- [Smi89] J. Q. Smith. Influence diagrams for statistical modeling. *Annals of Statistics*, 17(2):654–672, 1989.
- [Smi90] J.Q. Smith. Statistical principles on graphs. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 5, pages 89–120. John Wiley & Sons, 1990.
- [SN93] Ross D. Shachter and Pierre Ndilikilikisha. Using potential influence diagrams for probabilistic inference and decision making. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 383–390. Morgan Kaufmann, 1993.
- [SP89] Ross D. Shachter and M. A. Peot. Simulation approaches to general probabilistic inference on belief networks. In *Proceedings of the Fifth Conference on Uncertainty in Artificial Intelligence*, Windsor, Ontario, 1989. Morgan Kauffman.
- [SP90] Glenn Shafer and Judea Pearl. Introduction. In *Readings in Uncertain Reasoning*, chapter Chapter 1, pages 1–6. Morgan Kaufmann, 1990.
- [SP92] Ross D. Shachter and Mark A. Peot. Decision making using probabilistic inference methods. In *Proceedings of the Eighth Conference on Uncertainty in Artificial Intelligence*, pages 276–283. Morgan Kaufmann, 1992.
- [Spe79] Terry P. Speed. A note on nearest-neighbour Gibbs and Markov probabilities. *Sankhyā Series A*, 41:184–197, 1979.
- [Spe90] Terry P. Speed. Complexity, calibration, and causality in influence diagrams. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 3, pages 49–63. John Wiley & Sons, 1990.
- [Spi86] David J. Spiegelhalter. Probabilistic reasoning in predictive expert systems. In L. N. Kanal and J. F. Lemmer, editors, *Uncertainty in Artificial Intelligence*, pages 47–68. North Holland, Amsterdam, 1986.
- [Spi87] David J. Spiegelhalter. Probabilistic expert systems in medicine: Practical issues in handling uncertainty. *Statistical Science*, 2(1):25–30, 1987.
- [Spi90] David J. Spiegelhalter. Fast algorithms for probabilistic reasoning in influence diagrams, with applications in genetics and expert systems. In R. M. Oliver and J. Q. Smith, editors, *Influence Diagrams, Belief Nets, and Decision Analysis*, chapter 16, pages 361–384. John Wiley & Sons, 1990.
- [Spi94] Peter Spirtes. Conditional independence in directed cyclic graphical models for feedback. Technical Report CMU-PHIL-53, Carnegie Mellon University, Philosophy, Methodology, Logic, May 1994. to appear in *Networks*.
- [Spi95] Peter Spirtes. Directed cyclic graphical representations of feedback models. In *Proceedings of the Eleventh Annual Conference on Uncertainty in Artificial Intelligence*, Montreal, August 1995. Morgan Kauffman.
- [Spo80] W. Spohn. Stochastic independence, causal independence, and shieldability. *Journal of Philosophical Logic*, 9:73–99, 1980.
- [Sri92] Sampath Srinivas. Generalizing the noisy OR concept to non-binary variables. Technical Report TR-79, Rockwell International Science Center, 1992.
- [Sri93] Sampath Srinivas. A generalization of the noisy-or model. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 208–215. Morgan Kaufmann, 1993.
- [Sri95] R.P. Srivastava. The belief-function approach to aggregating audit evidence. *International Journal of Intelligent Systems*, 10(3):329–356, March 1995.
- [SS86] Prakash P. Shenoy and Glenn Shafer. Propagating belief functions using local computations. *IEEE Expert*, 1(3):43–52, 1986.
- [SS90] Prakash P. Shenoy and Glenn Shafer. Axioms for probability and belief-function propagation. In R.D. Shachter, T.S. Levitt, L.N. Kanal, and J.F. Lemmer, editors, *Uncertainty in Artificial Intelligence 4*. Elsevier Science Publishers B.V., North-Holland, 1990.

- [SSM87] Glenn Shafer, Prakash P. Shenoy, and Khaled Mellouli. Propagating belief functions in qualitative Markov trees. *International Journal of Approximate Reasoning*, 1:349–400, 1987.
- [SSS95] R.P. Srivastava, Prakash P. Shenoy, and Glenn Shafer. Propagating belief functions in AND-trees. *International Journal of Intelligent Systems*, 10(7):647–664, July 1995.
- [Sto93] Richard Stone. The assumptions on which causal inferences rest. *Journal of the Royal Statistical Society B*, 55(2):455–466, 1993.
- [Suz93] Joe Suzuki. A construction of Bayesian networks from databases based on an MDL principle. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 266–273. Morgan Kaufmann, 1993.
- [SV93] Moninder Singh and Marco Valtorta. An algorithm for the construction of Bayesian network structures from data. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 259–265. Morgan Kaufmann, 1993.
- [Tes92] Bjørnar Tessem. Interval probability propagation. *International Journal of Approximate Reasoning*, pages 95–120, 1992.
- [TS90] J. Tatman and R. Shachter. Dynamic programming and influence diagrams. *IEEE Transactions on Systems, Man, and Cybernetics*, 20:365–379, 1990.
- [VP92] Thomas Verma and Judea Pearl. An algorithm for deciding if a set of observed independencies has a causal explanation. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 323–330. Morgan Kaufmann, 1992.
- [VP93] T.S. Verma and J. Pearl. Deciding morality of graphs is NP-complete. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 391–397. Morgan Kaufmann, 1993.
- [WBG92] Michael P. Wellman, John S. Breese, and Robert P. Goldman. From knowledge bases to decision models. *Knowledge Engineering Review*, 7(1):35–53, March 1992.
- [WD94a] Chua-Chin Wang and Hon-Son Don. A polar model for evidential reasoning. *Information Sciences*, 77(3–4):195–226, March 1994.
- [WD94b] Chua-Chin Wang and Hon-Son Don. A robust continuous model for evidential reasoning. *Journal of Intelligent Robotic Systems: Theory and Application*, 10(2):147–171, June 1994.
- [Wel90a] Michael P. Wellman. *Formulation of Tradeoffs in Planning Under Uncertainty*. Pitman and Morgan Kaufmann, 1990.
- [Wel90b] Michael P. Wellman. Fundamental concepts of qualitative probabilistic networks. *Artificial Intelligence*, 44(3):257–303, August 1990.
- [Wel90c] Michael P. Wellman. Graphical inference in qualitative probabilistic networks. *Networks*, 20:687–701, 1990.
- [Whi90] Joe Whittaker. *Graphical Models in Applied Multivariate Statistics*. Wiley, 1990.
- [Wil90] Peter M. Williams. An interpretation of shenoy and shafer’s axioms for local computation. *International Journal of Approximate Reasoning*, 4:225–232, 1990.
- [Wil91] Nic Wilson. A Monte-Carlo algorithm for Dempster-Shafer belief. In *Proceedings of the Seventh Conference on Uncertainty in Artificial Intelligence*, pages 414–417, 1991.
- [WL89] N. Wermuth and S. Lauritzen. On substantive research hypotheses, conditional independence graphs and graphical chain models. *Journal of the Royal Statistical Society B*, 51(3), 1989.
- [WL90] N. Wermuth and S. Lauritzen. On substantive research hypotheses, conditional independence graphs and graphical chain models. *Journal of the Royal Statistical Society B*, 52:21–50, 1990.
- [WL94] Michael P. Wellman and Chao-Lin Liu. State-space abstraction for anytime evaluation of probabilistic networks. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*, San Mateo, Calif., 1994. Morgan Kaufmann.
- [XPB92] Yang Xiang, David Poole, and Michael P. Beddoes. Exploring localization in Bayesian networks for large expert systems. In *Uncertainty in Artificial Intelligence: Proceedings of the Eighth Conference*, pages 344–351. Morgan Kaufmann, 1992.
- [Xu91] Hong Xu. An efficient implementation of belief function propagation. In *Uncertainty in Artificial Intelligence: Proceedings of the Seventh Conference*, pages 425–432. Morgan Kaufmann, 1991.

- [ZHS88] Debra Zarley, Yen-Teh Hsia, and Glenn Shafer. Evidential reasoning using DELIEF. In *Proceedings of the Seventh National Conference on Artificial Intelligence*, pages 205–209, St. Paul, Minnesota, August 1988. Morgan Kaufmann.
- [ZP92] N. Lianwen Zhang and David Poole. Sidestepping the triangulation problem in Bayesian net computations. In *Uncertainty in Artificial Intelligence: Proceedings of the Eighth Conference*, pages 360–367. Morgan Kaufmann, 1992.
- [ZP94] Nevin Lianwen Zhang and David Poole. Intercasual independence and heterogeneous factorization. In *Proceedings of the Tenth Conference on Uncertainty in Artificial Intelligence*. Morgan Kaufmann, 1994.
- [ZQP93a] N. Lianwen Zhang, Runping Qi, and David Poole. Incremental computation of the value of perfect information in stepwise-decomposable influence diagrams. In *Uncertainty in Artificial Intelligence: Proceedings of the Ninth Conference*, pages 400–407. Morgan Kaufmann, 1993.
- [ZQP93b] Nevin Lianwen Zhang, Runping Qi, and David Poole. A computational theory of decision networks. *International Journal of Approximate Reasoning*, 11(2):83–158, 1993.