Description of paper "Quasi-Bayesian Networks", by Fabio G. Cozman

1) What is the original contribution of the work?

This paper presents a complete theory of directed acyclic graphs associated with convex sets of probability measures (called *Quasi-Bayesian networks*). The central contribution is a theory of Quasi-Bayesian networks that displays as much flexibility and representational power as the theory of standard Bayesian networks. Results in this paper show how to express judgements of irrelevance/independence in Quasi-Bayesian networks, and how to compute inferences from Quasi-Bayesian networks.

2) Why should this contribution be considered important?

This paper combines graphical models of inference (popularized in Artificial Intelligence by the theory of Bayesian networks) and convex sets of probability measures (used in Statistics, Artificial Intelligence, Philosophy, as a representation for imprecise/incomplete beliefs). From a theoretical point of view, this paper is important as it clarifies the relationship between graphical structure and independence relations in the presence of convex sets of probability measures. From a practical point of view, this paper is important as it demonstrates how to produce inferences from Quasi-Bayesian networks: how to represent convex sets of measures, how to represent independence judgements, and how to compute probability bounds using enumeration, iterative, and fractional programming approaches.

3) What is the most closely related work by others and how does this work differ?

Several authors have combined interval probabilities or convex sets of probability with graphical models; the work of Serafin Moral and his colleagues (e.g., An axiomatic framework for propagating uncertainty in directed acyclic graphs, *Int. J. of Approximate Reasoning*, 8:253-280, 1993) and Tessem (e.g., Interval Probability Propagation, *Int. J. of Approximate Reasoning*, 7:95-120, 1992) is the closest work to the present one. In previous work, concepts of independence have been proposed either to simplify computations, or to mimic similar concepts in standard probability theory. This has led to paradoxes and controversies regarding the semantics of Quasi-Bayesian networks, and has left the study of independence relations to the side. This paper, contrary to all previous work, starts from a definition of independence based on axioms of preferences (Peter Walley's definition of independence). This paper offers solid answers to questions related to the meaning of Quasi-Bayesian networks and to the manipulation of irrelevance/independence relations in Quasi-Bayesian networks.

4) How can other researchers make use of the results of this work?

Researchers can use the results of this work: (1) to represent imprecise and incomplete beliefs through directed acyclic graphs in a principled and efficient manner; (2) to conduct robustness analysis of standard Bayesian networks, as sets of probabilities can represent perturbations in probability values. This paper also describes the *JavaBayes* system and the *qb* package, two freely available packages produced by the author that allow any researcher to build and manipulate Quasi-Bayesian networks.

5) Other publications that contain part of this work.

Some algorithms described in this work have appeared in the paper "Local Robustness Analysis of Bayesian Networks using Convex Sets of Probability Distributions" (XIII Conference on Uncertainty in AI, 1997); some technical results have appeared in the paper "Irrelevance and Independence Relations in Quasi-Bayesian Networks" (XIV Conference on Uncertainty in AI, 1998). This paper is a significantly edited and improved version of part of the author's PhD dissertation, which appeared as the technical report "Decision-making with Convex Sets of Probability Distributions: Quasi-Bayesian Networks and Outdoor Visual Position Estimation" (Robotics Institute, Carnegie-Mellon University, CMU-RI-TR-97-49, 1997).