



THE UNIVERSITY OF
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Department of Statistics
DISSERTATION PROPOSAL

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**Interpretation, Inference and Identifiability of Linear Structural
Equation Models**

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ABSTRACT

Mixed graphs, containing both directed and bidirected edges, are commonly used as a representation for linear structural equation models. Structural equation models arise when the variables of interest are related through noisy functional relationships, and are popular due to their natural causal interpretability. I discuss progress on several problems pertaining to mixed graphs.

First, I examine their causal interpretability. A mixed graph is said to have a Gaussian causal interpretation if there exists a directed acyclic graph on a superset of the variables that determines the same Gaussian model as the given mixed graph. Restricting attention to the sub-class of chain graphs, I present a graphical characterization of precisely which chain graphs lend themselves to this interpretation.

Second, I turn to existence of maximum likelihood estimates. In particular, I present a graphical criterion for determining the minimum number of observations n required for the likelihood function to be bounded over a given acyclic mixed graph model on p nodes. This criterion makes use of a graph decomposition technique from Tian (2005) and in many cases, can offer a considerable reduction over the classical $n_{\perp} = p$ requirement necessary if no graphical structure were known.

Finally, I discuss the issue of identifiability in mixed graphs and outline the future direction of my research in this area. There have been a series of developments on generic identifiability of mixed graphs, most recently in Foygel, Draisma, and Drton (2012). The method used in their paper applies to both acyclic and cyclic mixed graphs, however an extension technique they propose does not apply in the cyclic case. I discuss plans to look at extending this work via an embedding of cyclic graphs into specially constructed acyclic mixed graphs. I also explore the possibility of applying their method to mixed graphs with one latent variable.

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