

CALD 10–702
Statistical Approaches to Learning and Discovery

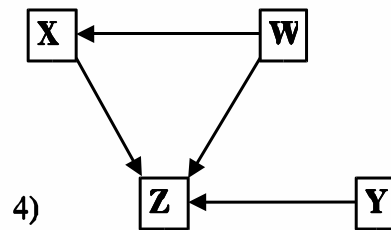
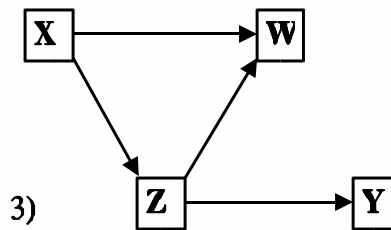
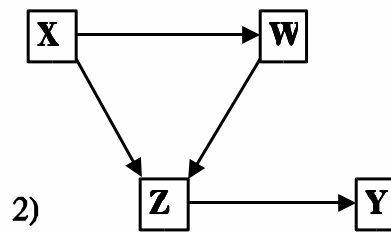
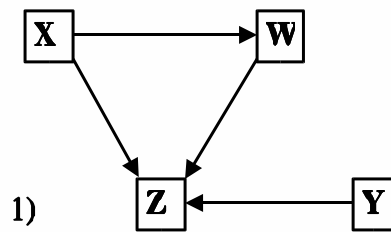
Assignment 3

March 18, 2003

Due in class on Wednesday, April 2.

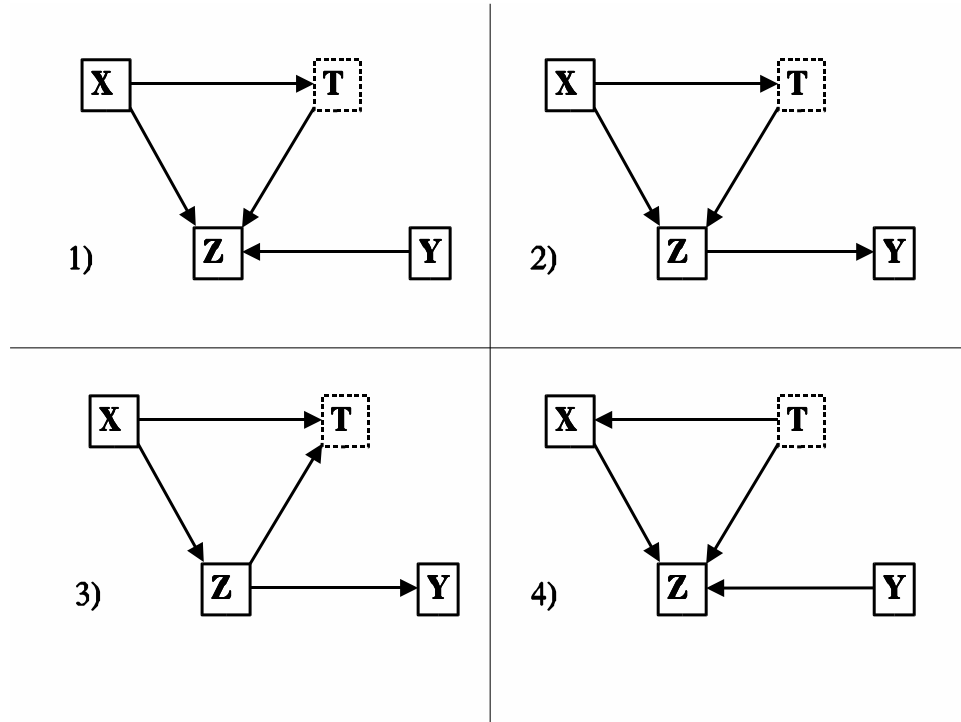
Problem 1. *D-separation equivalence without latent variables*

Partition the following four causal graphs into d-separation equivalence classes, and justify your answer.



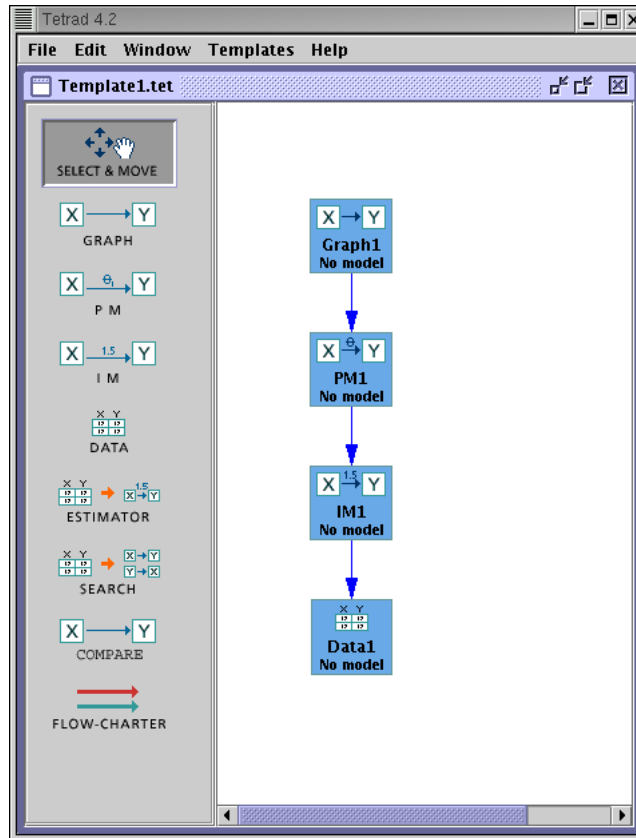
Problem 2. *D-separation equivalence with latent variables*

Let the set of variables $V = \{X, Y, Z\}$ be measured, and the set $\{T\}$ be latent, or unmeasured. Which of the following models are d-separation equivalent over V . Again, justify your answer.



Problem 3. *Tetrad 4 program*

3.1 Use the Tetrad 4 program (<http://www.phil.cmu.edu/tetrad/>) to interpret the four graphs in problem 2 as Structural Equation parametric models. Arbitrarily instantiate the parameters in each model, and from the instantiated models generate a data set with 5,000 data points. To generate data from a single model, the Tetrad workbench should look like as follows:



3.2 Save each data set on the hard disk, and use a statistical package like Splus, Minitab, etc., to estimate a regression model in which Y is the dependent variable and X and Z the independent variables. For each regression, report the estimate, t -statistic, and p -value of the coefficient expressing the effect of X on Y . For which models did regression accurately estimate whether X has any effect on Y ? Why?

Problem 4. *Bayes network*

The file calldata.txt (which is attached as a separate file) is a data set ($N = 1000$) over the variables $\{X, Y, Z\}$, where each variable is binary with values 0,1.

- 4.1 Estimate the conditional probability distribution $P(Z|X = 1)$.
- 4.2 Assume that X is the only direct cause of Z , and X is exogenous. Estimate the conditional probability distribution $P(Z|X \text{ set} = 1)$.
- 4.3 Assume that Z is the only direct cause of X , and Z is exogenous. Estimate the conditional probability distribution $P(Z|X \text{ set} = 1)$.