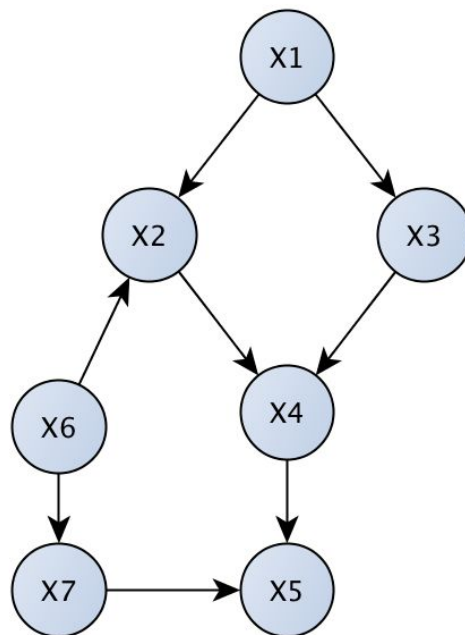


Homework 2: Causal Graphs, d-separation, and the back-door criterion

- (1) You have a joint distribution on three variables, $P(X_1, X_2, X_3)$. You've measured all dependencies in this distribution, and have only found one conditional independence relationship, $X_1 \perp X_2 \mid X_3$. Draw all possible causal graphs (assume they're acyclic) that can represent this distribution.
- (2) In the following graph, give a set Z that d-separates



- (a) X_1 and X_7
(b) X_2 and X_5
(c) X_1 and X_5
- (3) In the graph from (2), give a Z that satisfies the back-door criterion for the causal effect of
- (a) X_1 on X_7
(b) X_2 on X_5
- (4) Explain qualitatively how the sets from (2) and (3) are different. What is important about the paths left unblocked in (3) that were blocked in (2)?
- (5) Draw a causal graph for each of the following systems:

- (a) Large crowds cause trains to stay in the station longer. Staying in the station longer will make trains are late. If trains are late, you will be late for work. When you sleep in, you are late for work, but when you sleep in, the crowds on the train are smaller.
- (b) When demand for a product is high (i.e. many people want to buy it), the price goes up because vendors know they can charge more. When prices increase, demand decreases because fewer people are willing to buy expensive products. (Hint: Supply now will drive demand later. Demand now will drive supply later.)