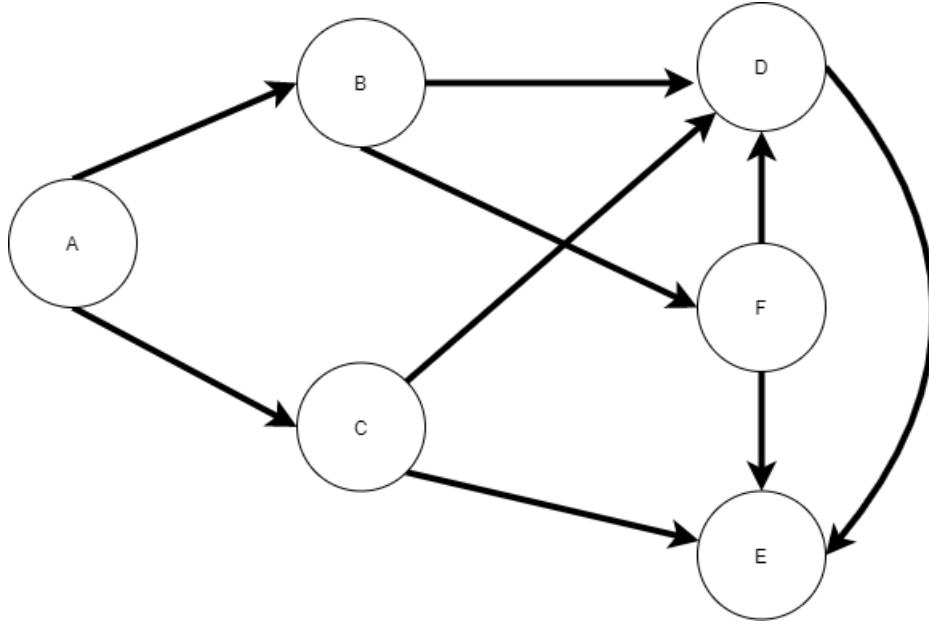


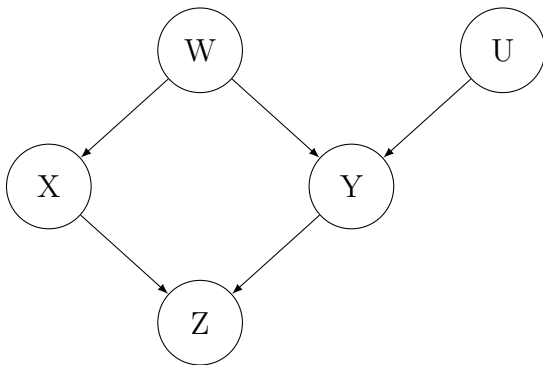
1 Converting BN to MRF



1. Convert the BN above to MRF.
2. Fill in the blanks to make a true statement: _____ and _____ are d-separated given _____ in the BN, but not d-separated in the MRF.

2 Conditioning vs. marginalization

Consider the following DAG G over variables $\{W, X, Y, Z, U\}$:

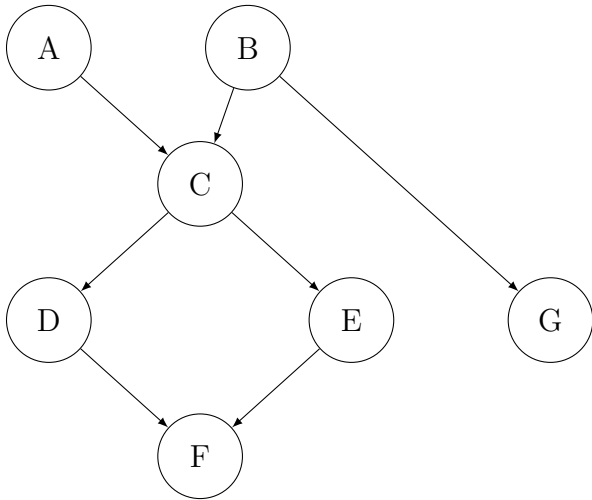


1. List all pairwise conditional independencies implied by d-separation in G . (Consider independencies of the form $A \perp B \mid S$ where A and B are single variables and S is a subset of the remaining variables.)

2. Now suppose we condition on Z (i.e., Z is always observed). Construct a new DAG G' over $\{W, X, Y, U\}$ that is a minimal I-map for the conditional distribution $p(W, X, Y, U \mid Z)$. Which edges must be added compared to simply removing Z from G , and why?
3. Instead, suppose we marginalize out Y (i.e., Y is unobserved). Construct a new DAG G'' over $\{W, X, Z, U\}$ that is a minimal I-map for $p(W, X, Z, U) = \sum_Y p(W, X, Y, Z, U)$. Justify any extra edges.

3 D-separation

Consider the following DAG over variables $\{A, B, C, D, E, F, G\}$:



For each of the following, state whether the conditional independence holds according to d-separation in this DAG. Justify each answer by identifying the relevant path(s) and explaining whether they are blocked or active.

1. $A \perp B$
2. $A \perp B \mid C$
3. $D \perp E$
4. $D \perp E \mid F$
5. $A \perp G \mid B$
6. $A \perp G \mid C$