1. Consider an HMM with three states, three outputs, and the following transition \( P(X_{t+1}|X_t) \) and emission \( P(E_t|X_t) \) models. Assume a uniform distribution for the initial state, \( X_0 \).

\[
\begin{array}{ccc}
X_t & X_{t+1} & a & b & c \\
\text{a} & 0.5 & 0.4 & 0.1 \\
\text{b} & 0.1 & 0.5 & 0.4 \\
\text{c} & 0.4 & 0.1 & 0.5 \\
\end{array}
\]

\[
\begin{array}{ccc}
X_t & E_t & p & q & r \\
\text{a} & 0.7 & 0.1 & 0.2 \\
\text{b} & 0.2 & 0.7 & 0.1 \\
\text{c} & 0.1 & 0.2 & 0.7 \\
\end{array}
\]

- Compute \( P(X_5|e_{0,5}) \) for the evidence sequence \( (E_0 = p, E_1 = p, E_2 = r, E_3 = r, E_4 = q, E_5 = r) \) by stepping through the forward algorithm by hand. Show your work.

2. Consider the Bayesian network given above. It has five variables: \{Windy (W), Burglary(B), Alarm(A), John Calls(J), Mary Calls (M) \}. Use the d-separation test to answer the following questions:

- Is J independent of M?
- Is B independent of W given A?
- Is M independent of W given A?
- Is A independent of B given W?
- Is B independent of J given A?

3. Construct two distinct DAGs over variables \( A, B, C, \) and \( D \). Each DAG must have exactly four edges and the DAGs must agree on d-separation.

4. Exercise 14.2 from R&N

5. (Optional) Exercise 14.6 from R&N