

Efficient Inference in Bayesian Networks

Exercise T12.1: Junction trees

(tutorial)

- (a) What are *cliques* and *separators*?
- (b) What is a *decomposable graph*?
- (c) What is the *running intersection property*?
- (d) Generate a junction tree from a directed acyclic graph (DAG).
- (e) How is evidence introduced to the junction tree?

Exercise T12.2: Message passing

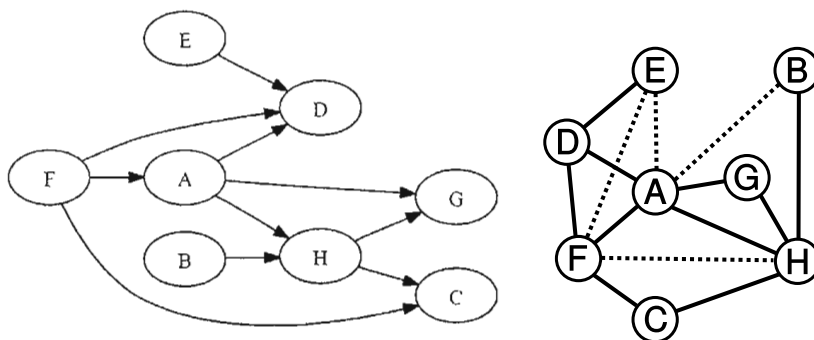
(tutorial)

- (a) What is a tree and what is a bipartite graph?
- (b) How can a conditional marginal be expressed by a bipartite tree?
- (c) Explain at an example (Lecture slides 3.2) how to perform marginalization.
- (d) How can all marginals be computed simultaneously by three message passes?
- (e) Formulate the *sum-product algorithm* for message passing.

Exercise H12.1: Construct a junction tree

(homework, 4 points)

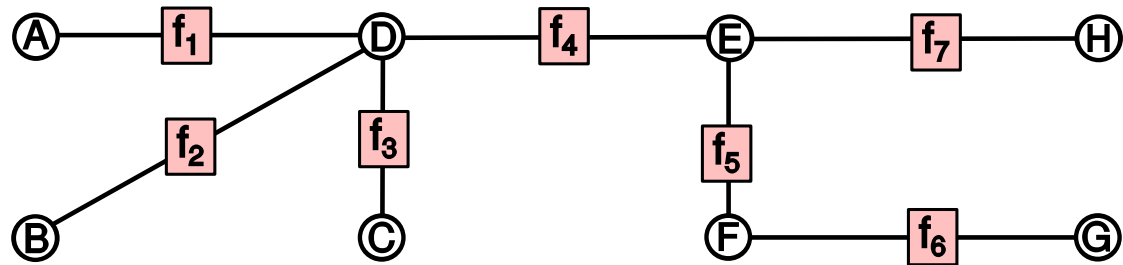
Given is a DAG (below left) and the corresponding moral graph (below right). The dotted edges in the latter are added during moralization.



- (a) (1 point) Determine the cliques of the moral graph.
- (b) (1 point) Draw the corresponding bipartite graph of cliques and separators.
- (c) (1 point) Construct one possible junction tree from the bipartite graph.
- (d) (1 point) Show that the *running intersection property* holds for your tree.

Exercise H12.2: Message Passing**(homework, 4 points)**

Given is the following junction tree:



- (1 point) Describe the order in which messages are generated in the “request”, the “collect” and the “distribute” pass, starting at node B .
- (1 point) Write out the computation performed for the message $\mu_{f_4 \rightarrow D}(D)$,
e.g. $\mu_{f_3 \rightarrow D}(D) = \sum_C f_3(C, D)$.
- (1 point) Write out the message $\mu_{f_4 \rightarrow D}(D)$ as in (b), after the evidence $F = f$ and $H = h$ has been observed.
- (1 point) Give respectively short expressions for evaluating of the following (conditional marginal) distributions.
 - $P(D|F = f, H = h)$
 - $P(A|F = f, H = h)$

Pay attention to the normalization coefficient. Note that it can be assumed that all necessary message have been passed, i.e., $\mu_{f_j \rightarrow X}(X)$ is available for all cliques j and respective variables X .

Total 8 points.