Assignment2: Bayesian Networks

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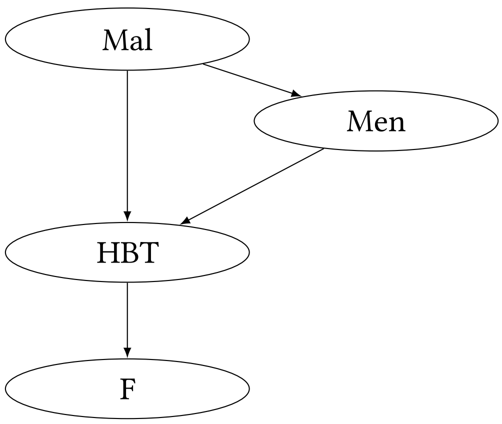
Exercise 2.3 (Medical Bayesian Network 2)

Both Malaria and Meningitis can cause a fever, which can be measured by checking for a high body temperature. Of course you may also have a high body temperature for other reasons. We consider the following random variables for a given patient:

- *Mal*: The patient has malaria
- *Men*: The patient has meningitis.
- *HBT*: The patient has a high body temperature.
- *F*: The patient has a fever.

1. Draw the corresponding Bayesian network for the above data using the algorithm presented in the lecture, assuming the variable order *Mal*, *Men*, *HBT*, *F*. Explain rigorously(!) the exact criterion for whether to insert an arrow between two nodes.



- *Mal*: *Men* - assume that *Mal* affects the *Men*; *HBT* - affects by far; *F* - given HBT, knowing *Mal* doesn't give any more information about F - no arrow.

- *Men*: *HBT* - affects by far; *F* - given HBT, knowing *Men* doesn't give any more information about F - no arrow.
- *HBT*: *F* - affects by far.

2. Which arrows are causal and which are diagnostic? Which order of variables would be better suited for constructing the network?

   $Mal \rightarrow HBT$ and $Men \rightarrow HBT$ are causal arrows. $HBT \rightarrow F$ is diagnostic arrow. Order Mal, Men, F, HBT would be better because we wouldn't have to think about adding arrows like $Mal \rightarrow F$. Which in the proposed order were not added only because of common sense. However, the network would look the same, only HBT and F would be swapped.

3. How do we compute the probability the patient has malaria, given that he has a fever? State the query variables, hidden variables and evidence and write down the equation for the probability we are interested in.

   Hidden variables: $Y = \{HBT, Men\}$
   Query variables: $X = \{Mal\}$
   Evidence variables: $E = \{F\}$
   $P(Mal|F) = \alpha P(Mal, F) = \alpha(\sum_{Men}\sum_{HBT} P(Mal, F, Men, HBT)) =$
   $\alpha(\sum_{Men}\sum_{HBT} P(Mal) \cdot P(Men|Mal) \cdot P(HBT|Mal, Men) \cdot P(F|HBT))$,
   where $\alpha = \dfrac{1}{P(F)}$