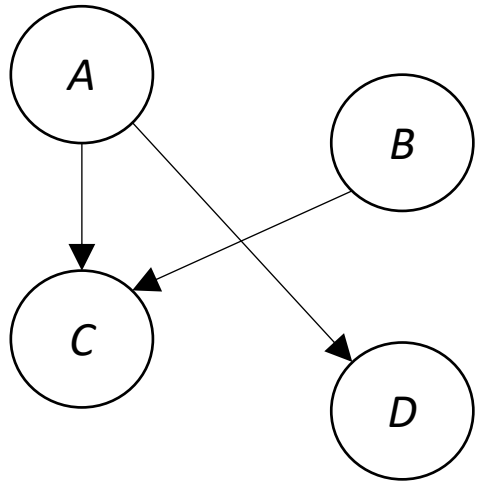
Knowledge Representation and Inference under Uncertainty: Bayesian Networks

Exercise



1. What are the PDFs associated to the nodes of the above BN?
2. Write the expression of the joint PDF represented by the BN
3. What conditional independence assumptions does it encode?
4. Assuming all variables are Boolean, derive an expression for

$$P(A = \text{true} | C = \text{true}, D = \text{true})$$

in terms of the PDFs associated to the BN nodes

Exercise

Boolean variables related to the state of a car, in alphabetical order

- *Battery*: it is false if the battery is dead
- *Fuel*: it is *false* if the fuel tank is empty
- *Ignition*: it is *true* if the ignition system works
- *Moves*: it is *true* if the car moves after one tries to start the engine
- *Radio*: it is *true* if the radio works when one tries to switch it on
- *Starts*: it is *true* if the engine fires when one tries to start it

1. Identify causal dependencies between the corresponding events
2. Draw a BN representing the joint PDF, making suitable conditional independence assumptions
3. Write the corresponding expression of the joint PDF
4. Can some of the PDFs be set based on *a priori* causal knowledge about the corresponding events?

Exercise

In a nuclear power station an alarm sounds and warning lights flash in the control room, when a sensor detects that the temperature of the core exceeds a given threshold.
On rare occasions the sensor measurement may be incorrect, resulting in false positive or false negative detections, especially when the external temperature is very high.
Occasionally, also the alarm and the warning lights can fail; to limit joint failures, they are implemented as physically separated systems.

1. Define a probabilistic model of this domain: a set of random variables, causal dependencies among them, and a BN to represent their joint PDF, making suitable conditional independence assumptions
2. Write the corresponding expression of the joint PDF
3. Derive an expression of the probability of a core overheating when warning lights are flashing in the control room, in terms of the PDFs associated to the nodes of your BN