

Decision Networks

David Albrecht

Overview

- Decision Network
- Urn Example
- Causal Links
- Standard Assumptions

Decision Network

- Also called Influence Diagrams.
- Decision Network is a DAG (Directed Acyclic Graph).
- Has three type of nodes:
 - Chance nodes (corresponding to random variables).
 - Decision Nodes.
 - Utility nodes.

Semantics

- Arcs into chance nodes:
 - Represent probabilistic dependence.
- Arcs into decision nodes:
 - Specify the information available at the time of the decision.
- Arcs into utility nodes:
 - Specify what parameters the utility depends upon.

A Simple Urn Problem

- Imagine a collection of 1000 urns.
 - 800 urns of type 1 and 200 urns of type 2.
 - Type 1 contains: 4 Red balls and 6 **Black** balls
 - Type 2 contains: 9 Red balls and 1 **Black** ball.
- Someone chooses a urn at random and asks you to decide what type it is.
- If you guess type 1 and you are correct you get \$40. If you are wrong you lose \$20.
- If you guess type 2 and you are right you get \$100. If you are wrong you lose \$5.
- For \$8 you are allowed to draw a single ball from the urn.

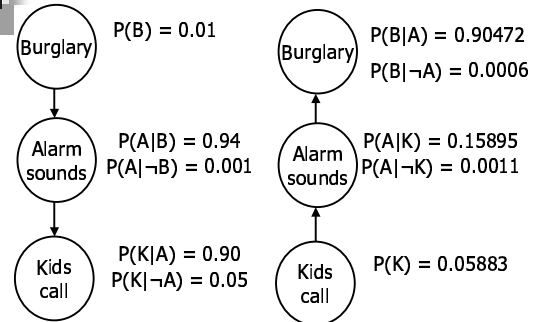
Experiments

- Now suppose you are allowed to make only one of the following experiments.
 - e_1 : For \$8 you are allowed to draw a single ball from the urn.
 - e_2 : For \$12 you can draw two balls from the urn.
 - e_3 : For \$9 you can draw a single ball from the urn with the option of another draw for \$4.50. You also have the option of replacing the first ball before drawing the second.

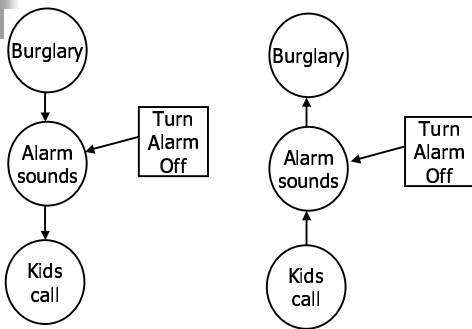
Types of Actions

- Non-intervening actions
 - Actions (decisions) which do not have a direct effect on the chance nodes.
 - E.g. Guessing which type of Urn.
- Intervening actions
 - Actions (decisions) that do effect a chance node.
 - E.g. Deciding to take a sample.

Equivalent Alarm Networks



Different Alarm Networks



Causal Links

- In Decision Networks:

"The impact of intervening actions can only follow the direction of causal links."

Common Assumptions

- No successors for utility nodes.
- There exists a directed path that contains all the decision nodes.
 - Same as requiring a total ordering of all decisions.
- All *no-forgetting arcs* included.
 - Everything which is known for a decision is also known for all subsequent decisions.
- Symmetric
 - The next chance node to be observed and set of decisions to be made are independent of the current observations and decision