

ARTIFICIAL INTELLIGENCE & CYBER SECURITY

BAYESIAN NETWORKS

Independence in Bayesian Networks

Estefanía Talavera Martínez
e.talaveramartinez@utwente.nl

UNIVERSITY
OF TWENTE.

Independence in BN

Detecting (conditional) independences in the factorisation of a joint distribution is not easy.

Independence of nodes in a graph can be found mechanically by operations on the graph

For the set of nodes A , B and C ,

$A \perp B \mid C$ if all the paths from A to B are blocked.



Independence in BN – types of nodes

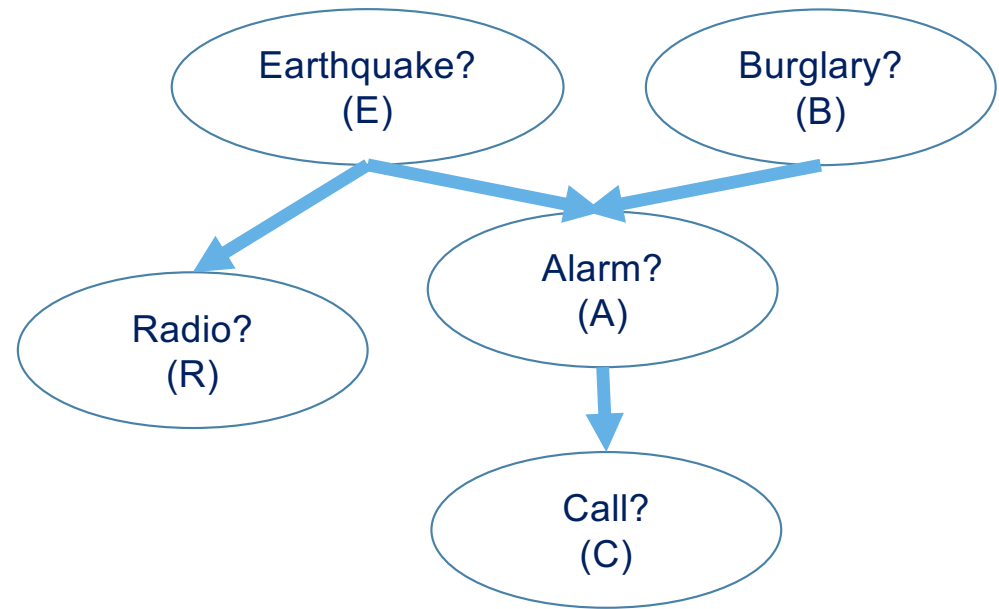
Sequential



Divergent



Convergent



Sequential ($W=A$):

A is intermediary between cause E and effect C

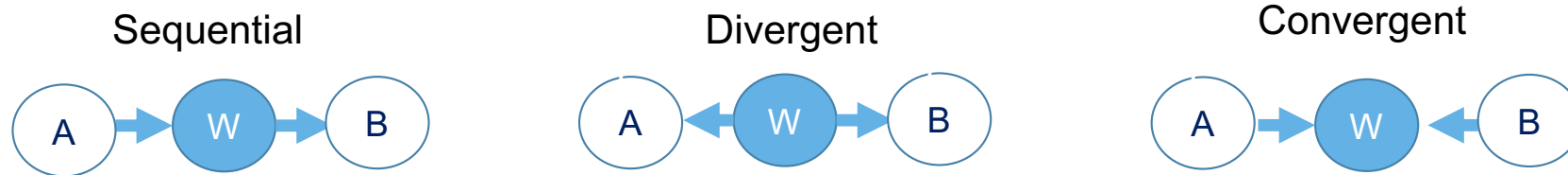
Divergent ($W=E$):

E is common cause of effects R and A

Convergent ($W=A$):

A is common effect of causes E and B

Independence in BN



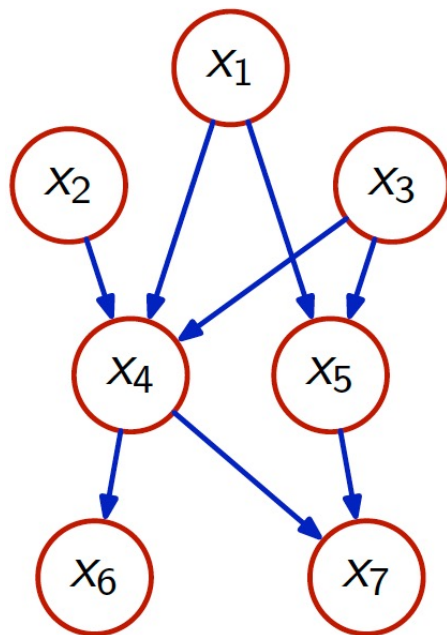
A path is blocked at a node when (d-separation)

- edges meet head-to-tail ($\rightarrow O \rightarrow$) or tail-to-tail ($\leftarrow O \rightarrow$) at a node which is in the observed set W ,
- edges meet head-to-head ($\rightarrow O \leftarrow$) at a node which is not in W , and none of whose descendants is in the observed set W .

$A \rightarrow W \rightarrow B$ or $A \leftarrow W \rightarrow B$,
 if W is observed
 then A does not affect B ,
 else, A does affect B

$A \rightarrow W \leftarrow B$,
 if W is not observed
 then A does not affect B ,
 else, A does affect B

Independence in BN



x_1, x_2, x_3 are independent when x_4 and x_5 are unknown.
They become dependent if either is known

x_6, x_7 are independent when x_4 is known

x_6 is independent of x_1, x_2, x_3, x_5, x_7 when x_4 is known