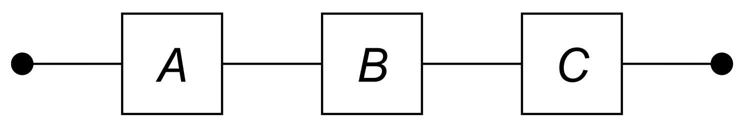
The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Reliability Block Diagrams

Network Quantification

Network Quantification

- Any RBD can be quantified to give:
  - P(system failure) using the minimal cut sets
  - P(system success) using the minimal path sets
- For example:



Min cut sets:
$\{A\}, \{B\}, \{C\}$

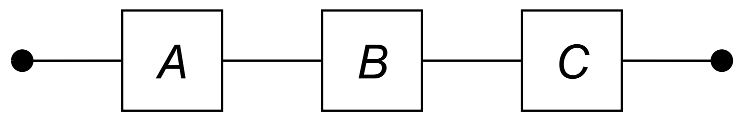
$Q_A = Q_B = Q_C = 0.1$

Min path sets:
$\{ABC\}$

$R_A = R_B = R_C = 0.9$

Network Quantification

Min cut sets:
$\{A\}, \{B\}, \{C\}$



Min path sets:
$\{ABC\}$

$Q_A = Q_B = Q_C = 0.1$

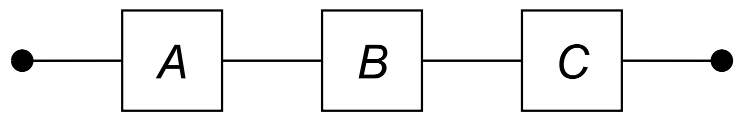
$R_A = R_B = R_C = 0.9$

- To find P(system failure) use the minimal cut sets:

$$\begin{aligned} \text{P(system failure)} &= \text{P}(A_F \vee B_F \vee C_F) \\ &= Q_A + Q_B + Q_C - Q_AQ_B - Q_AQ_C - Q_BQ_C \\ &\quad + Q_AQ_BQ_C \\ &= 0.3 - 0.03 + 0.001 \\ &= 0.271 \end{aligned}$$

Network Quantification

Min cut sets:
{A}, {B}, {C}



Min path sets:
{ABC}

$Q_A = Q_B = Q_C = 0.1$

$R_A = R_B = R_C = 0.9$

- To find P(system success) use the minimal path sets:

P(system success) $= P(A_W \wedge B_W \wedge C_W)$

$= R_A R_B R_C$

$= 0.729$

$= 1 - Q_{SYS} = 1 - 0.271$

Network Quantification

- It is normal to use the minimal cut sets during quantification
  - There are usually fewer minimal cut sets giving fewer terms in the inclusion-exclusion expansion,
  - If the number of minimal cut sets is large, approximations are applied,
  - When using minimal cut sets, each additional term of the inclusion-exclusion expansion becomes numerically less significant, meaning bounds can be found.

Summary

You should now be able to:

- Apply the inclusion-exclusion expansion to the network using:
  - Minimal cut sets
  - Minimal path sets