

Reliability Design

Set up a system

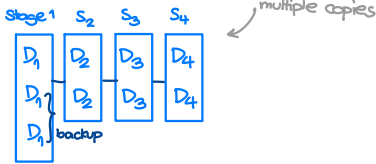
D_1 D_2 D_3 $D_4 \rightarrow$ #machine

C_1 C_2 C_3 $C_4 \rightarrow$ cost (each device have these)

r_1 r_2 r_3 $r_4 \rightarrow$ reliability (chance that it works perfectly)
 $= 0.9$ 0.9 0.9 0.9

Problem is I want to set up a system such that the reliability is maximum

Reliability of entire system $= 0.9^4 = 0.6561$ (walkways: 35% of that system fail)
 65% works perfectly



For the first device $r_1 = 0.9$ (probability of working)

$1 - r_1 = 1 - 0.9 = 0.1$ (probability of not working)

$(1 - r_1)^3 = 0.1^3 = 0.001$

$1 - 0.1^3 = 0.999$ (probability of 3 working)

0.999

สมมุติว่าเรามี extra copies

แต่ถ้าเราเพิ่มจำนวนก็จะมี cost ที่เยอะ devices เหล่านี้

"How many copies of each device should I buy? (within that cost)
 such that reliability of entire system is maximized"

example

$$\sum C_i = C_1 + C_2 + C_3$$

$$= 30 + 15 + 20 = 65 \text{ (นี่คือต้นทุนที่เรามีอยู่ทั้งหมด!!)}$$

$$\text{remaining: } C - \sum C_i = 105 - 65 = 40$$

$$\text{Upperband: } \left\lceil \frac{C - \sum C_i}{C_1} \right\rceil + 1 = \frac{40}{30} + 1 = 2$$

$$\left\lceil \frac{C - \sum C_i}{C_2} \right\rceil + 1 = \frac{40}{15} + 1 = 3$$

$$\left\lceil \frac{C - \sum C_i}{C_3} \right\rceil + 1 = \frac{40}{20} + 1 = 3$$

D_i	C_i	r_i	u_i
D_1	30	0.9	2
D_2	15	0.8	3
D_3	20	0.5	3

$C = 105$

Devices	Costs	Reliability	Upper bound
D_i	C_i	r_i	u_i
D_1	30	0.9	
D_2	15	0.8	
D_3	20	0.5	

$C = 105$

Consider D_1

$$S_1^1 = \{(0.9, 30)\}$$

$$S_2^1 = \{(0.99, 60)\}$$

$$S^1 = \{(0.9, 30), (0.99, 60)\}$$

Consider D_2

$$S_1^2 = \{(0.72, 45), (0.792, 75)\}$$

$$S_2^2 = \{(0.864, 60), (0.9504, 90)\}$$

$$S_3^2 = \{(0.8928, 75), (1.05, 105)\}$$

$$S^2 = \{(0.72, 45), (0.792, 75), (0.864, 60), (0.8928, 75)\}$$

reliability increase
 but cost decreases!
 IT'S WRONG

using dominant rule

REMOVE

Consider D_3

$$S_1^3 = \{(0.36, 65), (0.432, 80), (0.4464, 95)\}$$

$$S_2^3 = \{(0.54, 85), (0.648, 100), (0.6912, 115)\}$$

$$S_3^3 = \{(0.63, 105), (0.7254, 120), (0.7979, 135)\}$$

$$S^3 = \{(0.36, 65), (0.432, 80), (0.4464, 95), (0.54, 85), (0.648, 100), (0.6912, 115), (0.63, 105)\}$$

$$r_3 = 0.5$$

$$1 - (1 - r_3)^2 = 0.75$$

$$\cos^2 = 40$$

$$1 - (1 - r_3)^3 = 0.875$$

$$\cos^3 = 60$$



Final answer #

$$D_1 = 1 \text{ copy}$$

$$D_2 = 2 \text{ copies}$$

$$D_3 = 2 \text{ copies}$$