

d) i) cumulative gain = $1+1+0+1+1+0+0=4$

ii)

Discounted cumulative gain ($\log = \log_2$)

$$= 1 + \frac{1}{\log 2} + \frac{1}{\log 4} + \frac{1}{\log 5} = 1 + 1 + \frac{1}{2} + \frac{1}{2.3} = 2.93$$

Normalized Discounted cumulative gain

$$= \frac{DCG @ 7}{\text{ideal DCG @ 7}} = \frac{2.93}{1 + \frac{1}{\log 2} + \frac{1}{\log 3} + \dots + \frac{1}{\log 7}}$$

$$= \frac{2.93}{4.3} = 0.681$$