

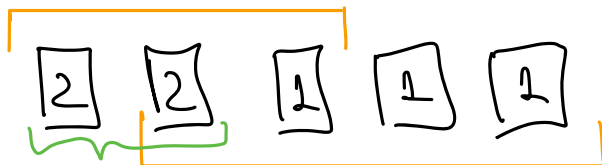
1. EGALITARIAN VOTING



$$(m=5, \Delta=1, f=1)$$

→ quorum contains $\left\lceil \frac{m+f+1}{2} \right\rceil$

2. AWARE Binary Voting



→ weighted quorum (at most $m-f$ and at least $2f+1$ replicas)

$2f V_{\max}$ replicas

$$V_{\max} = 1 + \frac{\Delta}{f}$$

$$V_{\min} = 1$$

3. Custom Multiple Weighting Scheme on AWARE

LOGICAL STEPS

A) Give all replicas the same weight 1

B) Apply weighted voting, but ensure a fallback strategy is still in place, hence leave $(m-f)$ replicas with weight 1 and give additional power to the other $2f$ nodes

C) In AWARE, $2f$ nodes are assigned V_{\max} , in the Custom Multiple Weighting Mechanism we need to come up with a "ranking system" that would give the best connected replica a higher vote than the others

$$2f V_{\max} = 2f \left(1 + \frac{\Delta}{f} \right) = 2f + 2\Delta \quad (*) \quad \text{for } 2f \text{ replicas} \rightarrow \text{in step A) we've already given weights to all replicas}$$

decreasing latency \rightarrow

$V_1 \quad V_2 \quad \dots$

$\downarrow \quad \downarrow$

$1 + \frac{1 \cdot \Delta}{m} \quad 1 + \frac{2 \cdot \Delta}{m}$

\downarrow

$1 + \frac{2f \cdot \Delta}{m}$

\Rightarrow

$\sum_{i=1}^{2f} V_i = \sum_{i=1}^{2f} \left(1 + \frac{i \cdot \Delta}{m} \right) = 2f + \frac{\Delta}{m} (1 + \dots + 2f)$

$= 2f + 2\Delta$

best connected replica

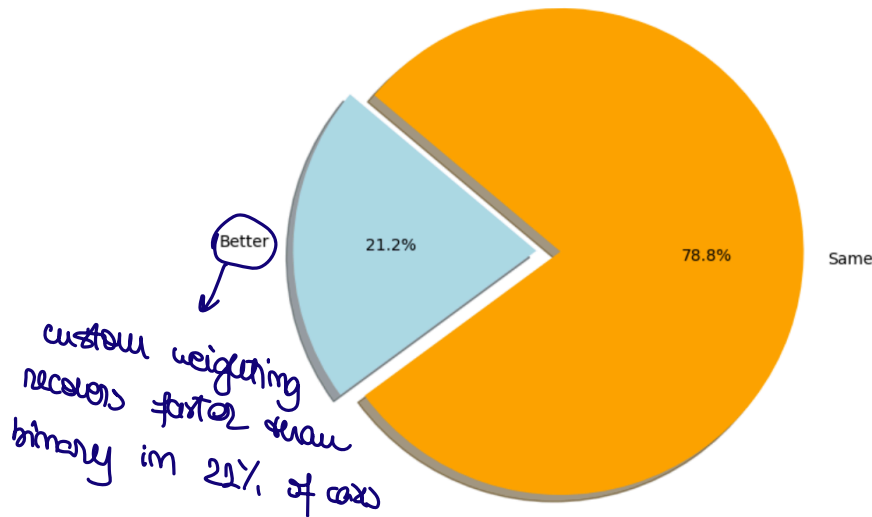
$$\Rightarrow \frac{1}{m} \frac{2f(2f+1)}{2} = 2f \Leftrightarrow m = \frac{f(2f+1)}{2}$$

$$\text{Hence, } V_i = \begin{cases} \frac{i \cdot D}{m}, & i = 1, 2f \\ 1, & i = \overline{2f+1, m} \end{cases}$$

Since this weighting distribution follows the same model as AWARE, the performance is the same and ensures the properties of a BFT quorum system

\Rightarrow ANALYSIS OF PERFORMANCE in case of faulty replicas

Custom vs Binary weights AWARE Recovery Performance



LIMITATIONS

\rightarrow leader being faulty \rightarrow but the behavior is the same for minority

\rightarrow the rest connected if replicas are faulty \Rightarrow consensus cannot be reached anymore with the rest

$$m = 3f + D + 1$$

$$V_{\max} \rightarrow 2f$$

$$V_{\min} \rightarrow f + D + 1$$

\Rightarrow even with all the V_{\min} weights we need $(f+D)$ weighted votes from the V_{\max} replicas

$$V_1 + \dots + V_f = f + \frac{D}{m} \frac{f(f+1)}{2} = f + \frac{D}{f(2f+1)} \cdot \frac{2 \cdot \frac{f(f+1)}{2}}{2} = f + D \cdot \frac{f+1}{2f+1} < f + D \Rightarrow \text{consensus cannot be reached,}$$