Tutorial#2

Rules

Recall

Q: Avg # of jobs in the system

$$\boxed{Q = \sum_i Q_i} \quad (15)$$

* general response time

$$\boxed{R = \sum V_i R_i} \quad (16)$$

* Interactive system (response time)

# of users

$$\boxed{R = \frac{N}{X} - Z} \quad (17)$$

throughput think time

* Bottleneck devices
→ Interactive system (18)

$$\boxed{X_{max} = \min\left(\frac{1}{D_{max}}, \frac{N}{\underbrace{D}_{\sum D_i}+Z}\right)}$$

(19)

$$\boxed{R_{min} = \max(D, N D_{max} - Z)}$$

# of jobs @
* knee point on throughput curve

$$\boxed{N^* = \frac{D+Z}{D_{max}}} \quad (49)$$

$N \leq N^* \longrightarrow$ no waiting

(remember Q*?)

Examples

1) $D_{cpu} = 5$ sec, $N = 17$
$Z = 18$ sec, $V_A = 80$
$S_A = 0.05$ sec, $V_B = 100$
$S_B = 0.03$ sec, $X_A = 15.7$
Response time? (interactive sys)

$$X_A = X V_A \longrightarrow X = \frac{15.7}{80} = 0.19625$$

$$R = \frac{N}{X} - Z = \frac{17}{0.19625} - 18 = 68.62 \text{ sec } \#$$

2) For a time-sharing sys with disks A & B, the probabilities for jobs completing the service @ the cpu were found to be 0.8 (P_{CA}) to A, 0.16 (P_{CB}) to B. The user think time is 5 sec (Z). The disks service time = 30, 25 ms (S_A, S_B) for A, B & 20 ms (S_{cpu}) for the cpu. Using a machine interactive repairman model with central server queuing subsys.

i) For each job → visit ratios

$$P_{cpu,0} = 1 - 0.8 - 0.16 = 0.04$$

$$V_{cpu} = \frac{1}{P_{cpu,0}} = 25$$

$$V_A = \frac{P_{CA}}{P_{C,0}} = \frac{0.8}{0.04} = 20 \qquad \boxed{1+20+4}$$

$$V_B = \frac{P_{CB}}{P_{C0}} = \frac{0.16}{0.04} = 4$$

ii) total service demand for each D

$D_{cpu} = V_{cpu} S_{cpu} = 0.5$ sec

Bottleneck device → $D_A = V_A S_A = 0.6$ sec

$D_B = V_B S_B = 0.1$ sec

$U_i = X_i S_i$

iii) If disk U_A is 60%, What' R U_{cpu}, U_B?

$U_A = X V_A S_A \rightarrow X = \frac{U_A}{\underbrace{V_A S_A}_{D_A}}$

$X = \frac{0.6}{0.6} = 1$

$U_B = X D_B = 0.1$

$U_{cpu} = X D_{cpu} = 0.5$

iv) What's the avg response time where there are 10 users (with same X in iii) ?

R N

$R = \frac{N}{X} - Z = \frac{10}{1} - 5 = 5 \text{ sec}$

v) Bottleneck dev → A

vi) min avg response time

$R_{min} = max(D, ND_{max} - Z)$

$= max(\underbrace{0.5 + 0.6 + 0.1}_{1.2}, \underbrace{10(0.6) - 5}_{1}) = 1.2 \text{ sec}$

vii) max throughput

$X_{max} = min(\frac{1}{D_{max}}, \frac{N}{D+Z})$

$= min(\underbrace{\frac{1}{0.6}}_{1.67}, \underbrace{\frac{10}{1.2+5}}_{1.61}) = 1.61$

viii) max possible disk A utilization.

$U_A)_{max} = X_{max} D_A$

$= (1.61)(0.6) = 0.966$

3) Consider the following

$S_{cpu} = 0.04$ sec

$V_{cpu} = 25$

$S_A = 0.04$ sec $\quad V_A = 20$

$S_B = 0.02$ sec $\quad V_B = 4$

$Z = 5$ sec

a) What changes in CPU speed that would achieve response time = 10

$R = 10$ sec $\rightarrow N = 25$

$D_{cpu} = S_{cpu} V_{cpu} = 0.04 \times 25$
$= \boxed{1 \text{ sec}}$ Bottleneck

$D_A = S_A V_A = 0.04 \times 20 = 0.8$ S

$D_B = S_B V_B = 0.02 \times 4 = 0.08$ S

$R_{min} = max(D, ND_{max} - Z)$

$= max(1.88, 25(1) - 5)$

$\therefore 10 = ND_{max} - Z$

$D_{max} = \frac{10 + 5}{25} = 0.6$ S

$D_{cpu} = 0.6$ But now D_A is the bottleneck device

$D_A = D_{cpu} = 0.6$ sec

$D_{cpu} = V_{cpu} S_{cpu}^*$

$S_{cpu}^* = \frac{0.6}{25} = 0.024$ sec

speed $= \frac{1}{S^*_{cpu}} = \frac{1}{0.024} = 41.67$ /sec

chang in speed $= \frac{41.67 - \frac{1}{0.04}}{41.67}$

$= 0.4$

b) find the B.N device if

i) CPU speed is doubled

$S^*_{CPU} = \frac{1}{2} S_{CPU} = 0.02$ sec

$D^*_{CPU} = 0.5$ sec

$D_A = 0.8$ sec , $D_B = 0.08$ sec

B.N

ii) Disk A is replaced with a disk twice slow

B.N

$D_A = 2 \times 0.8 = 1.6$ sec

$D_{CPU} = 1$ sec , $D_B = 0.8$ sec

iii) If memory size is reduced so that jobs make 20 more times to disk$_B$ due to increased Page faults

$V^*_B = 4 + 20 = 24$

$D^*_B = V^*_B S_B = (24)(0.02) = 0.48$ sec

$V^*_{CPU} = 1 + \underbrace{V_A}_{20} + \underbrace{V^*_B}_{24} = 45$

$D^*_{CPU} = V^*_{CPU} S_{CPU} = (45)(0.04) = 1.8$ sec

B.N

$D_A = 0.8$ sec