| PART-(D) |

CSE-534

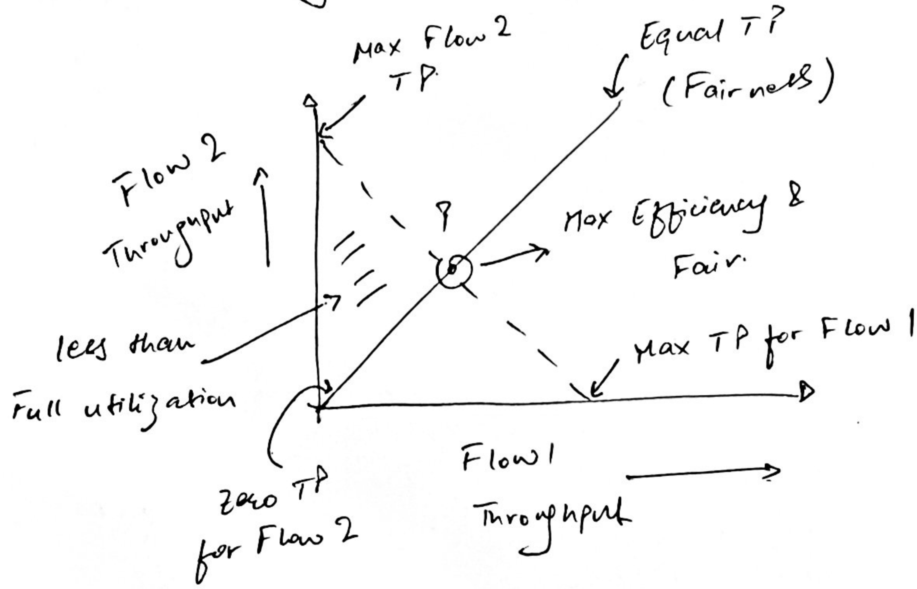
Homework #2

BHAVESH GOYAL

(111482386)

To compare the fairness of different increase-decrease algorithms, we consider the following Relational Graph b/w 2 flow's throughputs

TP: Throughput



- 2 flows are considered to be Fair if they converge towards Point 'P' (Ideal case), or converge towards distribution for $\boxed{f(y) = y}$ (Identity).

Case I: MIMD

The congestion window varies as:

$$c(t+1) = \begin{cases} b_1 c(t) & ; \text{ no loss} \\ b_0 c(t) & ; \text{ else} \end{cases}$$

; here $c(t)$ ⇒ Size of congestion window at time 't'.

where $b_1 > 1$, $0 < b_0 < 1$

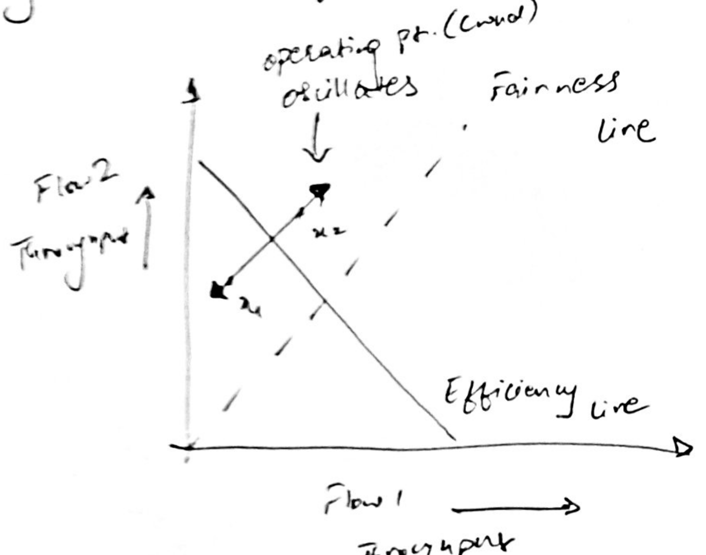
We observe that 'Dah-Ming CHIU et al.' define a Fairness factor as

$$F = \left\{ \frac{\left(\sum_n c(t)\right)^2}{n \sum_n c^2(t)} \right\} \text{ For 'n' observations}$$

Thus, for large enough 'n', F should converge towards P.

Now, taking two points x_1, x_2 for MIMD,

we find, Throughput Graph for MIMD looks like



(Since, x_1, x_2 always scale by a const.)

→ MIMD does not converge to a central pt and is not fair.

Case II: AIAD

Here, $c(t+1) = \begin{cases} a_1 + c(t), & \text{no loss} \\ a_2 + c(t), & \text{else} \end{cases}$

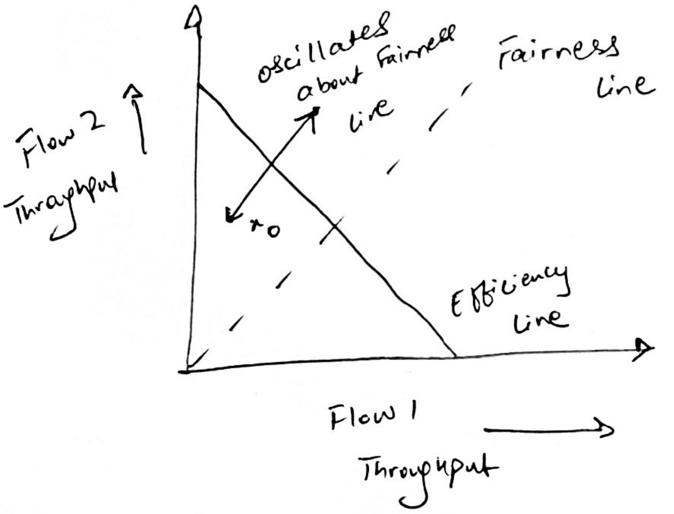
$\rightarrow a_1 > 0$
$a_2 < 0$

A similar scenario is observed when consecutive $c(t_i)$'s are plotted.

Here $F = \dfrac{(x_1+x_2)^2}{2(x_1^2+x_2^2)}$ } oscillate along the Fairness line with an additive factor and Fairness function never actually

converges towards fairness line.

Flow Comparison is as shown:



⇒ The 2 flows never converge unless operated at the ideal congestion window point itself. ⇒ AIAD is not fair.

Case III: MIAD.

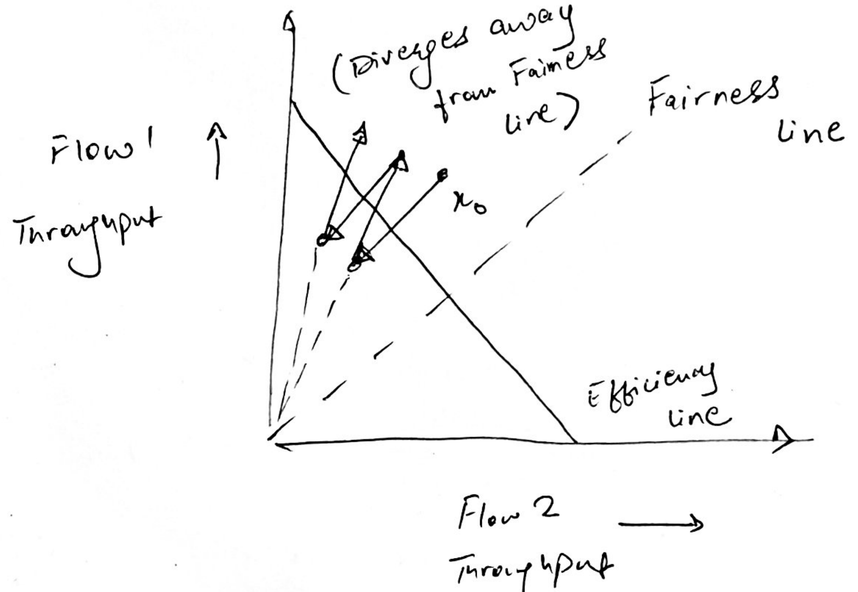
Here, $c(t+1) = \begin{cases} b_1 c(t), & \text{no loss} \\ c(t) + a_0, & \text{else} \end{cases}$

$b_1 > 1 \; ; \; a_0 < 0$

In this case we see that for consecutive windows for 2 flows, the window size grows scalably, but decrease happens only a little by the factor of a_0. ⇒ This gives us an intuition that over time, throughput of one of the flows is going to dominate other.

In other words, MIAD causes graph to converge in opposite direction than required (More suitable word would be to diverge)

This is agreed by Fairness Plot as Shown:



Case IV : AIMD

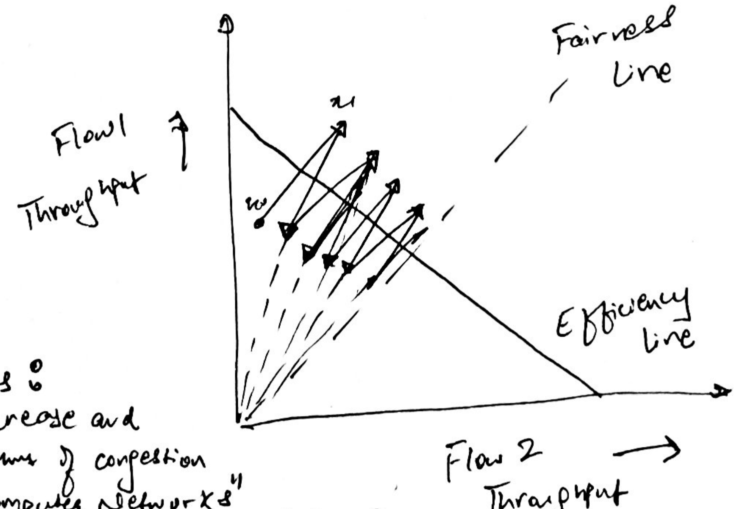
$$c(t+1) = \begin{cases} c(t) + a_1, & \text{no loss} \\ b_0 \cdot c(t), & \text{else} \end{cases}$$

$a_1 > 0$

$0 < b_0 < 1$

In this case we see that converge function F, does converge towards Fairness line. Since two flows only additively increase window sizes and fall back really fast on a loss, taking small steps increasing the congestion window sizes would eventually make 2 flows converge to a point. This is shown in the Flow graph, where window sizes are symmetric to $y = x$.

→ Decrease Must be Multiplicative & Increase Additive to ensure Fairness



References :
- Fairness functions :
↳ "Analysis of Increase and Decrease Algorithms of congestion Avoidance in Computer Networks" (DAH-MING CHIU, RAJ JAIN)