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E DELL'INFORMAZIONE

IOT Homework - Exercise 3

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1.1. 1

1.1.1. Computation of L_4

Knowing that $L_N(r)$ is computed via the recursive formula:

$$L_N \;=\; r_i \;+\; \sum_{i=0}^{N-1} P(S=i)\, L_{N-i},$$

we can extract the following formula:

$$L_N = \frac{r_i + \sum_{i=1}^{N-1} P(S=i)\, L_{N-i}}{1 - P(S=0)}.$$

When $N = 4$ and $r_i = 4$, numerically we found:

$P(S=0) = 0.15625$

$P(S=1) = 0.1875$

$P(S=2) = 0.5625$

$P(S=3) = 0$

$P(S=4) = 0.09375$

Substituting into the previous formula:

$$\begin{aligned} L_4 &= \frac{4 + 0.1875\, L_3 + 0.5625\, L_2 + 0\;\; L_1 + 0.09375\, L_0}{1 - 0.15625} \\ &= \frac{4 + 0.1875 \times 6.375 + 0.5625 \times 4}{0.84375} = \frac{7.4453125}{0.84375} \approx 8.8241. \end{aligned}$$

1.1.2. Efficiency for $r_1 = 1...6$

For each initial frame r_1, the total mean resolution time is

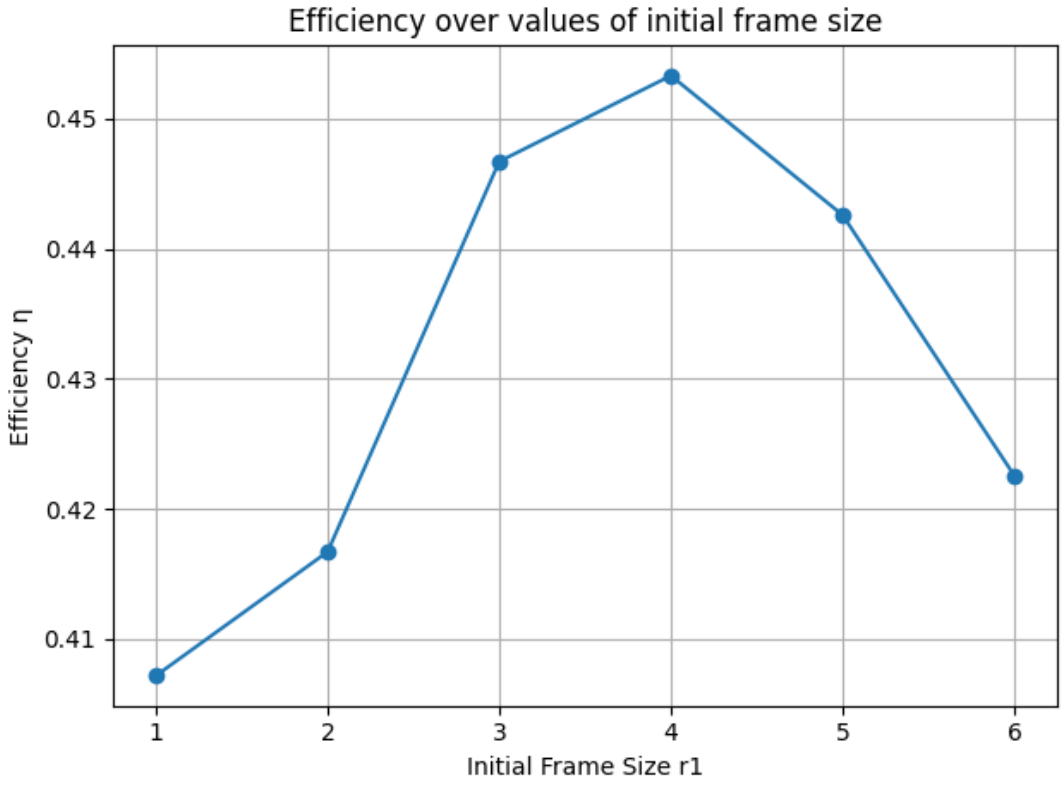
$$\mathbb{E}[T] = r_1 + \sum_{i=0}^{3} P(S = i)\, L_{4-i},$$

where $P(S = i)$ is recomputed for each r_1. The *efficiency* is $\eta = 4/\mathbb{E}[T]$, after all the computations we get:

r_1	$\mathbb{E}[T]$	η
1	9.8241	0.4072
2	9.5995	0.4167
3	8.9544	0.4467
4	8.8241	0.4533
5	9.0377	0.4426
6	9.4661	0.4226

We observe the maximum efficiency $\eta \approx 0.4533$ at $r_1 = 4$.

1.2. 2



1.3. 3

From the results, we observe that the efficiency η reaches its maximum value of approximately 0.4533 when the initial frame size is r1=4, which matches the number of tags N=4.

This happens because when the frame size matches the backlog size, the probability of having exactly one tag per slot is maximized. This reduces both collisions and slots that are not chosen, which are both sources of inefficiency.