EXERCISE 1: Consider the *special* M/M/1 queuing system (hereafter *system*) the state-transition-rate diagram of which is shown in Figura 3.1. Complete the following tasks:

1. interpret the *starred* states when the system models an Internet router;

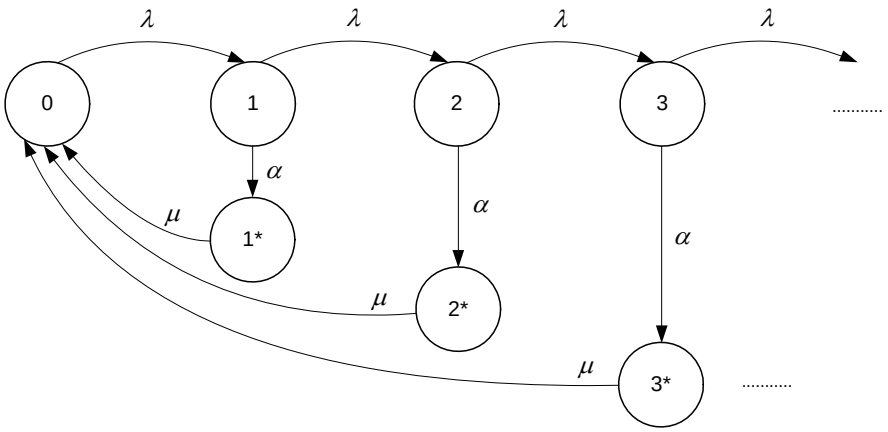

Figura 3.1: The state-transition-rate diagram

2. write the global balance equations around states $\{n\}$, $\forall n \geq 1$, and calculate the relationship between p_n and p_0;
3. write the global balance equations around states $\{n^*\}$, $\forall n^* \geq 1$, and calculate the relationship between p_{n^*} and p_n;
4. by using results of the previous two points, establish the *system stability condition* and, for a stable system, calculate the steady state probabilities;
5. calculate the *probability mass function* of the number of packets observed by an arriving *tagged packet* and by the *random observer.*

From now on, by assuming $\alpha = \mu$:

6. calculate the packet loss probability P_L and the rate λ_{acc} with which packets are accepted by the system;
7. calculate formally the throughput γ as a function of λ and P_L;
8. calculate the relationship between the *offered load* a and the *carried load* a';
9. calculate the average number of packets $E[N]$ in the system .