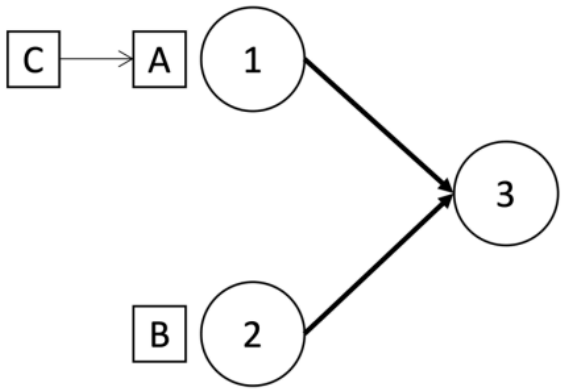
1 Problem 1:

Consider the queuing system in the figure, where packets whose service is completed by Servers 1 and 2 go to Server 3. The service time of Server 1, 2, and 3 is exponential with rate $\mu_1 = 1$ pks/s, $\mu_2 = 2$ pkt/s and $\mu_3 = 3$ pkt/s, respectively. At time t = 0, packet C arrives in the buffer of Server 1. When C arrived, Server 1 has packet A in service while Server 2 has packet B in service.



a) Compute the probability that A exits the system before any other packets move to server 3.
b) Compute the probability that B exits the system before any other packets move to server 3.
c) Compute the expected time T needed by Packet A to exist the system.

2 Problem 2:

Consider a router receiving packets according to a Poisson process $\{N(t), t \geq 0\}$ with rate $\lambda = 4$ packets/second.

a) Compute the probability that the router will receive 2 packets in the next second.
b) Compute the expected number of packets received up to time t = 2s
c) Imagine that 2 packets arrived in the time interval from 0 to the end of 3s, compute the probability that between the start time of $t = 4$ and at the end of time $t = 6$ exactly 4 packets arrive at the router (Hint: Consider the expression $P(N(6) - N(4) = 4)$).

3 Problem 3:

A router sends out 15 packets every 3 seconds on average. Suppose that the time in between two packets sent out can be modeled as an exponential random variable.

a) What is the probability that the next packet will be sent out after 5 seconds?
b) What is the probability that exactly 5 packets will leave in the next second?
c) What is the probability that exactly 5 packets will leave in the next 2 seconds?
d) What is the probability that more than 4 packets, but less than 7 packets will leave in the next 2 second?

4 Problem 4:

A router is receiving packets from two different clients. Assume the time between the generation of two consecutive packets at each client is exponentially distributed with parameters $\lambda_1 = 1$ packets/second for client 1, and at $\lambda_2 = 2$ packets/second for client 2.

a) What is the probability that the next packet will come from node 1?
b) What is the probability that the router will receive exactly 3 packets in the next 4 second?
c) Imagine that at time $t = 2$, two packets have arrived at the router. At $t = 4$, what is the probability that at least 1 more packets will arrive?