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Stats 417

**Project # 4**

**Part 1**: Problem description

The goal of this project was to simulate an M/M/1 queue, that assumes customers come according to a poisson process with a rate of 0.5 people per minutes and the service time, which follows an exponential distribution with a mean of 3 minutes. The mean waiting time for the system was then calculated from the simulation.

**Part 2**: Discussion of results:

customerNo arrival.time waiting.time start.time service.time end.time

1 1 164.0818 0.0000 164.0818 191.406645 355.4885

2 2 246.6834 108.8050 355.4885 502.827815 858.3163

3 3 372.8273 485.4890 858.3163 289.251434 1147.5677

4 4 405.7486 741.8191 1147.5677 68.797809 1216.3655

5 5 530.4832 685.8823 1216.3655 188.896581 1405.2621

6 6 569.0803 836.1817 1405.2621 139.348712 1544.6108

7 7 726.2754 818.3354 1544.6108 123.311931 1667.9227

8 8 747.8018 920.1210 1667.9227 335.119116 2003.0419

9 9 1021.1598 981.8820 2003.0419 56.730161 2059.7720

10 10 1124.9096 934.8624 2059.7720 330.499174 2390.2712

11 11 1209.1121 1181.1591 2390.2712 48.845312 2439.1165

12 12 1344.7694 1094.3471 2439.1165 281.304623 2720.4211

13 13 1468.2365 1252.1846 2720.4211 50.195103 2770.6162

14 14 1498.4691 1272.1472 2770.6162 55.993592 2826.6098

15 15 1501.8106 1324.7992 2826.6098 138.288310 2964.8981

Average wait time: 3303.412

In the simulation that I developed, a sample run with the first 15 customers is presented above. The key to a simulation such as the M/M/1 queue is that when a customer arrives, if there is no one being helped then the wait time will be 0. Otherwise, the wait time will be the difference between when the last customer finishes and the arrival of the next customer. This simulation determined was run for 100 customers and a time of 30,000. The average wait time that was determined for this simulation was 3303.412. The reason for the average wait time in this simulation being so high is that, as the number of customers approached 100, the wait times were very large. For the sample of the data included above for the first 15 customers, the average wait time is 923.193 which is a much more manageable number.

This is a somewhat unrealistic simulation as there would be more instances than the first time that there was no waiting time but is an accurate representation of the model of the problem. In future simulations, I think that are better models that would reflect real life applications in a better way and I would lean towards using one of those queues instead. Also, changing some of the input variables such as the time.close may create a more accurate model for this situation.

**Part 3**:

**Code:**

sim.store=function(arrival.lambda=1/120,service.lambda=1/180,time.close=30000)    
{  
  arrival.time=rexp(1,rate=arrival.lambda)  
  if(arrival.time<time.close)  
  {   
    start.time=arrival.time      
    waiting.time=0      
    service.time=rexp(1,rate=service.lambda)     
    end.time=start.time+service.time    
    customers=data.frame(customerNo=1,arrival.time,waiting.time,start.time,service.time,end.time)

    customer.count=1  
    wait=0

    while(customer.count<1000)  
    {        
      arrival.time=arrival.time+rexp(1,rate=arrival.lambda)

      if(arrival.time>time.close){break}

      start.time=max(arrival.time,end.time)     
      waiting.time=start.time-arrival.time        
      wait=wait+waiting.time        
      service.time=rexp(1,rate=service.lambda)        
      end.time=start.time+service.time        
      customer.count=customer.count+1

      customers=rbind(customers,c(customerNo=customer.count,arrival.time,waiting.time,start.time,service.time,end.time))   
    }    
  }   
  print(customers)    
  print("Average waiting time is: ")    
  print(wait/customer.count)    
}

sim.store()