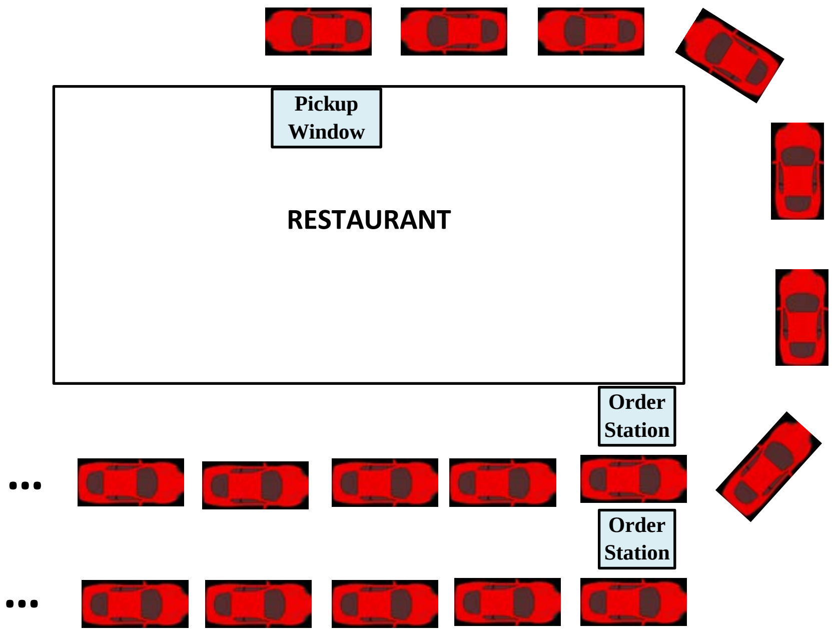
CS 4830/6830
Programming Project 1

For your first simulation project, you will design a simulation of a restaurant drive-thru facility using SimPy. The drive-thru consists of a pair of order stations and payment/pickup window. There is a limited amount of space for cars in the overall drive-thru facility so the owner of the restaurant would like to optimize throughput of cars to maximize profit during the lunch rush that occurs from 11 AM – 1 PM. The diagram shown above illustrates the



layout of the facility. There is space for one car at each station (order stations and pickup window). There is space for 6 cars between the pick-up/payment window, and there is also space for 10 cars waiting to reach the order window. Due to space limitations, if the number of cars waiting to reach the order station exceeds 10 (5 per lane), no additional cars will join the line.

You may assume that a customer's arrival at the restaurant is described by an exponentially distributed random variable with a mean interarrival time of approximately AR minutes. The time to place an order is also defined by an exponentially distributed random variable with a mean order time of 2 minutes per order. The time to prepare a food order is described by an exponentially distributed random variable with a mean preparation time of 5 minutes and the time to pay and collect an order is also determined by an exponentially distributed random variable with a mean of 2 minutes per order.

When a car arrives at the restaurant, the customer will decide if they want to enter the waiting line or leave immediately. If the order line has less than 10 cars waiting, the car will always join the shortest line. Once a car enters an order line, they will wait to reach the order station, place their order, wait to reach the pick-up window, pay for their order, and finally pick up their food and exit the system. No customer ever leaves the line once they begin waiting.

Once a customer reaches the order station, they place their order. The time to place the order is determined by sampling an exponentially distributed random variable with a mean of 2 minutes. Once the customer completes his or her order, if there is space available, the car moves forward and the next car moves up and begins placing an order. Inside the restaurant as soon as an order is taken, food preparation begins. The time to complete the food preparation is determined by sampling an exponentially distributed random variable with a mean of 5 minutes. When a car reaches the pickup window, the server processes the payment in a time determined by an exponentially distributed random variable with a mean of 2 minutes. At the end of this time, the customer collects their order and leaves the restaurant and the next car moves forward.

For this project, you are to investigate two different service scenarios. The first scenario is described above. In the second scenario, assume human servers are stationed outside the restaurant (one per order station). These servers move from the order station position down the waiting line taking orders on a mobile device (i.e. the physical service station is not used to place orders). Assume that in this scenario, the time to place an order is described by an exponentially distributed random variable with a mean service time of 1.5 minutes per order. In addition, assume that customers now pay at the time the order is placed so the time of pickup an order is still described by a randomly distributed exponential variable but the mean service time is reduced to 1 minute. As before food preparation can begin as soon as an order is placed.

Once you develop your simulation you will need to conduct a simulation study to determine (1) for scenario #1 what is the upper limit on mean interarrival time (AR) of customers that can be maintained in steady-state without a significant number of customers exiting the system without service (2) does scenario #2 increase customer throughput and if so at what value of mean interarrival time (AR) should the restaurant switch from scenario #1 to scenario #2, (3) what is the upper limit on mean interarrival time (AR) of customers that can be maintained in steady-state without a significant number of customers exiting the system without service under scenario #2.

When you have completed your simulation experiments, write a brief report (~3 pages) describing your experimental design, simulation results with your recommendations.

You have the option to work as a team of two on this project