# DISCRETE SIMULATION MODELLING

## Project Arena

**Use Arena to consider the following simulation problems**

(1) Fine Fast Foods (FFF) is interested in looking at their staffng for the lunch period running from 10am to 2pm. People arrive on foot, by car or bus as follows:

- **On foot** – one at a time, interarrivals are exponential with mean 3 minutes. The first customer arrives at a time `Exp(3)` minutes after 10am.
- **By car** – with 1, 2, 3 or 4 in a car with respective probabilities 0.2, 0.3, 0.3 and 0.2. Interarrivals are distributed as exponential with mean 5 minutes; the first car arrives `Exp(5)` minutes after 10am.
- **A single bus** arrives every day sometime between 11am and 1pm (arrival time is uniformly distributed over this period). The number of people on the bus varies from day to day but it appears to follow a Poisson distribution with a mean of 30 people.

Once people arrive either alone or in a group from any source, they operate independently regardless of their source. The first stop is with one of the servers at the order/payment counter where ordering takes `TRIA(1, 3, 4)` minutes and payment then takes `TRIA(1, 2, 3)` minutes: these two operations are sequential, first order-taking and then payment, by the same server for a given customer. The next stop is to pick up the food ordered, which takes an amount of time uniformly between 30 seconds and 2 minutes. Then each customer goes to the seating area, which has 30 seats (people are willing to sit anywhere, not necessarily with their group). Consuming food takes `TRIA(11, 20, 31)` minutes. After that the customer walks to the door and leaves. Queuing at each of the three 'service stations' (order/-pay, pickup food, seating area) is allowed with FIFO discipline. There is a travel time of `EXPO(30)` seconds from each station to all but the exit door (entry to order/pay, order/pay to pickup food, pickup food to seating). After eating, people move more slowly, so the travel time from the seating area to the exit is `EXPO(1)` minute.

The servers at both order/pay and pickup food have a single break that they share on a rotating basis. More specifically at 10:50, 11:50, 12:50 and 1:50 one server from each station goes on a 10 minute break: if the person due to go on break at a station is busy at break time he or she finishes serving the customer but still has to be back at 11, 12, 1 and 2 respectively (so the break could be shorter than 10 minutes).

Staffing is the main issue at FFF. currently there are 6 servers at the order/pay station and 2 at the pickup food station throughout the 4 hour period. Since they know that the bus arrives sometime during the middle 2 hours they are considering a variable staffing plan that for the first and last hour would have 3 at order/pay and 1 at pickup food and for the middle 2 hours would have 9 at order/pay and 3 at pickup food (note that the total number of person-hours on the payroll is the same 32 under either the current staffing plan or the alternate plan, so the payroll costs are the same). What's your advice?

*In terms of output, observe the average and maximum length of each queue, the average and maximum time in each queue, and the total number of customers completely served and out the door. Make plots of the queues to get into order/pay, pickup food, and the seating area.*

(2) At a doctor's office, a patient arrives on average once every 20 minutes. Patients first have to go to a unique check-in desk staffed by a medical assistant, providing their name and insurance data. This process takes from 30 seconds and 2 minutes. After that, patients have to sit in the waiting room, until the doctor is available. The doctor calls the patients in the same order they arrived. The check-up time with the doctor take on average 15 minutes, with a standard deviation of 3 minutes. After the check-up, about half of the patients need a prescription, the doctor writes the prescription in 1 minute, on average. Both prescription and non-prescription patients go to the check-out desk to pay the fee and schedule the next appointment. This typically takes 45 seconds. The same medical assistant is staffing the check-in and the check-out desks. Model the doctor's office in Arena and simulate this model for 10 replications of 8 hours. On average, what is the total time spent in the office by a patient? What is the maximum waiting time in the waiting room?

The doctor is considering hiring a second medical assistant to have an assistant specifically assigned to the check-in and

check-out processes. Implement this change in the model. Is this a good idea?