Business Decision Analytics under Uncertainty
Spring 2017, Professor Eckstein
Homework 9, Due Wednesday, April 19

For each problem, build a YASAI model and hand in the standard printouts for a simulation problem (values, formulas, and simulation results). Your spreadsheets should have long sequences of repetitive, copied rows; you need not print out all of these rows.

Q1: Leasing drain-cleaning equipment — queuing with balking

You have just taken over management of the local "Roto-Blaster" franchise, which performs emergency drain cleaning. Based on data from the previous management, the number of requests for service you receive each day appears to have Poisson distribution with an average value of 8.5. You receive $179 for each service call you answer.

You can arrange long-term contracts to lease two kinds of equipment, *regular blasters* and *super blasters*. A regular blaster costs $275/day to lease and can serve up to 3 calls per day. A super blaster cost $415/day to lease and can serve up to 5 calls per day. You are considering all 9 possible combinations of leasing either 0, 1, or 2 regular blasters and 0, 1, or 2 super blasters (although the 0/0 option means essentially shutting down the business).

Depending on how many of each kind of blaster you lease, you may not have enough capacity to service all the customers who might call on a given day. Historical records suggest that each customer who wants service, but is not served by the end of the day, has an independent 43% chance of "giving up" and finding another firm to resolve their problem. The rest remain with you and try to obtain service the next day.

Using a sample size of at least 1000, simulate a 100-day period.

Which blaster configuration should you lease to obtain the highest average profit? With this arrangement, what is the average number of customers giving up per day? If you limit your choice of policies to those with an average of at most 0.5 customers giving up per day, which blaster configuration gives you the best profit?

Q2: Castings: a combination of part replacement and queuing

You have a business heat-treating specialty industrial castings. The number of castings you receive for treatment each day is a Poisson random variable with a mean value of 4.1. You process the castings in a super-high-temperature oven that can hold up to 5 castings. This oven uses a heating element that sometimes fails; the probability of failure is as follows:

Day of Use	Failure Probability
1	1%
2	7%
3	9%
4	15%
5	25%

After the fifth day of use, the safety regulations for the oven require that the heating element be replaced even if it is still functioning.

On days that the heating element fails, you must wait until the next day to reprocess all the castings for that day. Thus, on days that the heating element is working, you have a total processing capacity of up to 5 castings, but on days that it fails, your capacity is effectively 0 castings.

You process the castings on a first-come, first-served basis — if you cannot finish all the castings waiting to be processed on a given day, you save them in a queue and try to process as many as possible the next day.

You are considering 5 possible policies, parameterized by a number d = 1, 2, 3, 4, or 5. At the *end* of the day, if the heating element has been in use for d days and has not failed, you replace it. On days when the element fails, you also replace it at the end of the day.

The economics of the operation are as follows:

- The heating element costs $800 to replace if it did not fail
- When the element fails, it costs $1500 to replace
- You receive $200 in revenue each time you finish processing a casting
- You estimate that each day that each casting spends waiting to be processed costs you $40 in loss of goodwill, storage costs, etc.
- You may assume all other costs and revenues to be negligible.

Determine by simulation which value of d gives you the highest expected profit over a 60-day period. You may ignore any costs and revenues from castings left in queue at the end of the period. Use a sample size of at least 500, and assume that you start with a new heating element on the first day.

You are also interested in whether the queue of unprocessed castings left at the end of the day exceeds 10 at any time during the 60-day period. With the optimal value of d, what is the probability of this event?