MATHS 2103 Probability and Statistics
Project 2 - Queues

Due: Friday, 1 June 2018, 4 pm (Week 12).

Eeylops Owl Emporium, a retail store which sells owls and other owl-related supplies such as food and cages, has some problems with its checkouts. While the self-service checkouts do save Eeylops Owl Emporium money, they are also causing customers to become frustrated by the long wait times *before* they can start scanning their goods. It seems some people can take an unusually long time to scan their items. The retail store want a short report (no more than 10 pages) detailing possible outcomes, discussing the differences between *the self-service checkouts* and *checkouts with people*.

As this report is for nonmathematicians, any mathematical techniques/tools/equations will need to be explained clearly and concisely. You will need to address any limitations, possible sources of errors and any modelling assumptions, while detailing possible solutions or fixes to these probems.

Facts that you need to know:

- Due to safety regulations, Eeylops Owl Emporium can only permit 60 people inside at any one time. Therefore, the queue can contain, at most, 60 people. However, some stores have a much larger capacity. Therefore, your analysis should be on a queue length of 60 but you should hypothesise what might happen for larger queues. For example, would there be a difference, or would there be similar outcomes?
- We will assume we have two completely separate systems; these systems are not linked in any way. Both systems are one-server queues, however they have different parameters.
- We denote the probability the queue increases over a small period (say, 1 second) as

  $$\lambda,$$

  and the probability the queue decreases in the same period as

  $$\mu.$$

  As such, the probability the queue does not change in length in the same period is

  $$1-(\lambda+\mu)\,.$$

- After years of study, Eeylops Owl Emporium has determined a (large) range for λ and μ for both types of check outs. These ranges are given in the table below.

	Self Service	Regular
λ	[0.1, 0.8]	[0, 0.6]
μ	[0, 0.8]	[0.2 0.8]

  Note: For whatever values of λ and μ that are chosen, the relation $\lambda+\mu\leq 1$ must hold.

- Be aware that the probabilities above assume that
  - The queue is not full. If the queue is full, the queue cannot increase.
  - The queue is not empty. If the queue is empty, the queue cannot decrease.

  Make sure you account for these two scenarios in the probabilities above. Think about the implications of this on the possible values of λ and μ.