Discrete-event simulation model of homeless care system

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Discrete-event simulation (DES) is a form of stochastic simulation which models the evolution of a complex system according to a chronological event list which is updated throughout the simulation. DES is a powerful modeling tool given its ability to incorporate bespoke system complexities. It also naturally accomodates stochasticity by using a stream of Uniform$(\min = 0, \max = 1)$ pseudo-random numbers to drive the generation of random variates for model variables such as inter-arrival and service times. A single run of a DES model can be computationally cheap to run. However, one must run a DES model many times to obtain an output distribution, which means using such a model is computationally expensive.

We have developed a DES model for homeless care systems, which is based upon the DES model of Singham et al. (2023) for the homeless care system in Alameda County, California, US. In our model, shelter acts as a server, giving rise to a tandem queueing system, as illustrated in Figure 1.

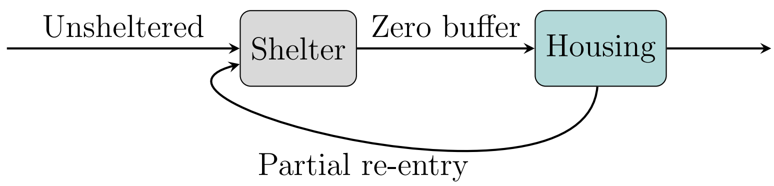

Figure 1: Tandem queueing system with re-entries

Here we list some key model inputs for the DES model:

- Possion arrival process with rate 1 person per day.
- The service time at shelter is modelled as exponential with mean 6 months.
- The service time at housing is modelled as exponential with mean 5 years.
- 17% of those leaving housing re-enter the queue for shelter, reflecting estimates from Alameda County.
- Number of houses rises from 40 to 80 by the end of year 1, then remains constant.
- Number of shelters rises from 15 to 20 by the end of year 1, then remains constant.

In Figure 2 we plot model outputs given 100 simulation replications.

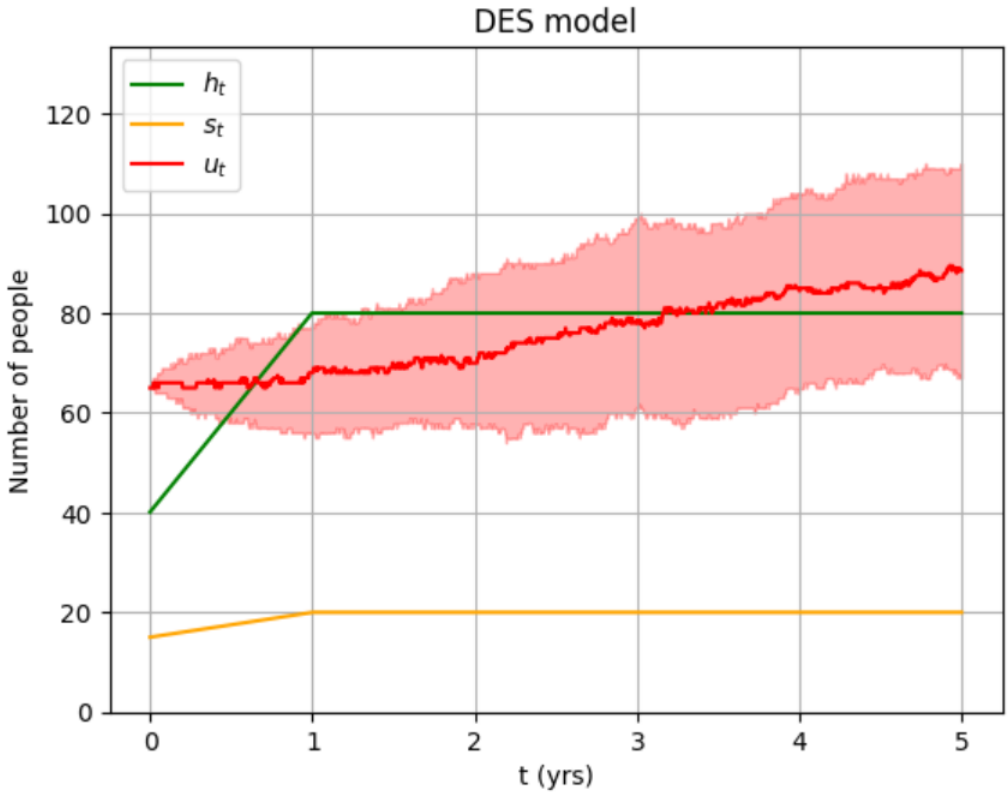

Figure 2: DES modelling of homeless care system. Dynamics of u_t (unsheltered queue) in red. Thick line shows median, with 10th to 90th percentile shaded. Model inputs for s_t (number of shelters) and h_t (number of houses) given in orange and green, respectively.

References

Singham, D. I., Lucky, J., and Reinauer, S. (2023). Discrete-event simulation modeling for housing of homeless populations. *Plos one*, 18(4):e0284336.