PhD progress updates

February 20, 2024

w/c 12 Feb 2024

- Brainstorming of new deterministic optimisation formulations based on the fluid flow model and to be solved using Pyomo.
- 'Wrapping up' before taking leave: to-do lists, my current thinking down on paper, expanding of SO reading list.

w/c 5 Feb 2024

- Development of fluid flow model in Python
- Development of deterministic optimisation framework for our problem in Python (with Pyomo)
- Solving continuous version of simple housing vs. shelter problem (we looked at discrete version before Christmas with full enumeration of solution space and the analytical M(t)/M/s(t) model).

w/c 29 Jan 2024

- Discussion of the details of a rolling-horizon approach
- Study of Pyomo implementations of SAA formulations of infinte dimension SO problems with shape constraints.
- Study of SO algorithms for integer-order decision varialbes (e.g. R-Spline, Discrete Stochastic Approximation and COMPASS)
- Beginning a document to collect my notes on different SO algorithms, including discussion of how to categorise different algorithms and what charateristics (of algorithms) we may be interested in during this PhD work.
- 4-month appraisal at STORI.

w/c 22 Jan 2024

- Preparation for STOR-i 4 month appraisal
- Reasonably detailed study of the STRONG paper and brief look at the STRONG implementation in the SimOpt library
- High level study of three papers from DS looking at Sample Avg Approx. of infinite dimensional SO problems with shape constraints.
- Some consideration of whether the latter SAA approach could be applied to our housing waiting list problem.

w/c 15 Jan 2024

- Study of the SimOpt library:
  - How the library organises models/problems/solvers/experiments with Python classes - reasonably confident I could adapt our python simulation model so it could be incorporated into this infrastructure for testing.
  - Overview of problems and solvers in the library. A couple of the problems bear resemblence with our model (including an M/M/1 problem and a Facility Capacity service problem). Aside from a Random Search algorithm, there are only 6 solvers - all of which are specifically for continuous-valued decision variables and box constraints.
  - Test experiment with an M/M/1 problem with service rate as decision variable and an objective function to minimise mean sojourn time plus a penalty term proportional to squared service rate.

w/c 8 Jan 2024

- Poster presentation at STORi conference. Some interesting feedback:
  - Despite up front cost, there could actually be a return for investment in housing - i.e. in the long run if occupants found work and were able to pay rent to stay there. Also - when the property is sold a profit could be made.
  - Given these development decisions are long-term decisions which are typically not made overnight with the very latest data, the motivation for fast algorithms is not necessarily so strong as it is in other applications.
- New notebook (06_analytical_model_vs_t.ipynb) to look not just at the single objective value for the development decisions we have modelled, but to look at their performance over a full 10 year model run, to understand their impact over time. This is motivated by the fact that the time horizon of interest affects the decision.

w/c 18 December 2023

- Further reading (e.g. multi-fidelity SO) following interesting talks at Winter Sim 2023
- Studying Dave's work on analytical approximations of M(t)/G/s(t) queues
- Reviewing my work (from before my US trip) using analtyical model
- Some computing admin such as proper use of virtual environments for my coding

27th November - 15th December 2023

- Trip to US including:
  - Meeting stakeholders in homeless response services in San Francisco / Oakland CA
  - Research visit to NPS Monterey
  - WSC 2023 in San Antonio TX
- Detailed notes on the outcomes of this trip found in separate report

w/c 20th November 2023

- Continue working on the simple experiment discussed last week, with extensions including:
  - making build-decisions in the first four years, but letting the model run for a total of 10 years,
  - examining more closely the effect of changing the cost of shelter by changing this in smaller increments

- Draw out the key takeaways from this simple experiment in six takeaways - summarised in the document entitled '05_analytical_model_what_we_know.pdf'
- Explore the effect on the decision-making by changing the arrival rate function which we use.
- (To be explored between writing this and meeting on 23 Nov): explore a solution space which involves building extra accommodation at two points in time, rather than just one.
- Meeting with Dashi and more detailed plans for California trip, to include meeting two or three people who work in tackling homelessness in the San Fran Bay area.

w/c 13th November 2023

- Perform a simple experiment to measure the effect of the following points on a simple objective function (expected value of time average of size of unsheltered Q), where the effects of adding extra shelter are compared to the effects of adding extra housing, and therefore the preference between adding extra shelter or housing can be studied.
  - adding accommodation (housing or shelter) at different points in time
  - changing the relative cost of shelter compared to housing
  - changing the rate at which customers are served in housing
- Make a list of what we currently know about our model of the homelessness response system
- Meeting with Burak Buke to discuss analytical methods of modelling the homelessness response system

w/c 6th November 2023

- Add functionality to ranking_and_selection.py to be able to quickly find true optimal solutions, using the analytical model, with a given a) cost of building shelter relative to housing, b) mean service time for housing, c) objective function.
- Using this functionality, look a how cheap shelter needs to be for it to be preferential compared to housing, for a range of service-time means, with a simple objective function with one linear term.
- Assuming shelter is half the price of housing, explore (using the simulation model) the effect of a non-zero service time at shelter, on the preference for housing over shelter.
- Meeting with Dashi - discussing trip and research - suggestion that desire for initial ramping up of shelter is to quickly take people out unsheltered queue who have been there for some time.
- Planning of trip to NPS / Winter Sim.
- Communication with lead analyst in Homelessness & Rough Sleeping (HRS) stats team in UK Dept. for Levelling Up, Housing & Communities (DLUHC) who offered to put me in contact with HRS policy/analytical colleagues in due course.

w/c 30th October 2023

- The current setup favours housing over shelter as early as possible because extra housing not only removes someone from the unsheltered queue (since someone from shelter can enter housing, and someone unsheltered can then move into shelter) but it also conducts service and increases the rate at which customers are leaving the system.

- Using this setup, re-run once the R&S algorithm using the indifference-zone parameter exactly equal to the true difference (from the analytical model) between the best and second-best solution, setting alpha = 0.05.
- Re-run many times the same algorithm on the same solution space, now setting alpha to 0.25 - in theory this should lead to at least 75% confidence on the optimal solution found.
- Now, halve the cost of shelter to give shelter an advantage over housing. Use the the analytical model to study the effect of this - the optimal solution now says shelter is better, the earlier the better.
- The setup now favours the advantage of shelter (cheaper) over the advantage of housing (which increases the rate of customers leaving system).
- Test this setup with the possibility of building only shelter or only housing or a mix. Now that we favour shelter, the result is to choose only shelter (i.e. best true objective function value). Remember we are just minimising the average size of the unsheltered queue.
- Consider an objective function which is a function of both the unsheltered and sheltered queue. The form of this function could enable us to ensure, for example, that we do not want unreasonably large unsheltered or sheltered queues.
- Begin reading of "Integer-Ordered Simulation Optimization using R-SPLINE" (Wang, 2013).

w/c 23rd October 2023

- Develop new disctete solution space which is more suitable for testing the R&S algorithm (i.e. not quickly clearing the unsheltered queue)
- Use analytical model to gain better understanding of the optimal solution (i.e. housing better, the earlier the better). An extra housing unit is better than an extra shelter unit because it not only removes someone from the unsheltered queue (since someone from shelter can enter housing, and someone unsheltered can then move into shelter) but it also conducts service and increases the rate at which customers are leaving the system.

w/c 16th October 2023

- Development of Ranking & Selection algorithm (KN algorithm) to minimise the average size of unsheltered queue
- Develop initial choice of discrete solution space for testing R&S algorithm

w/c 9th October 2023

- Complete and test first version of DES model (to allow discrete/continuous solution space)

w/c 2nd October 2023

- Begin development of DES model in Python

w/c 25th September 2023

- Decide upon problem formulation
- More reading into possilbe SO algorithms for our choice of problem formulation

w/c 18th September 2023

- Study papers on models for runaway homeless youth populations

- Suggest several options for problem formulations (cost minimisation / benefit-cost maximisation etc.)