Next: Preliminary results from first floor CAD

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Key points

- We have run our seat selection code over the old building first floor layout, based on the provided CAD file.
- We achieved a maximum seat occupancy, with a 2m social distancing measure, of approximately 45% without shielding, a significant improvement on the benchmark supplied at 28%.
- We have developed a new web-based application which is specific to the Next first floor layout, available here.

What we could do next

- Given the potential shield locations in the CAD file, we could simulate scenarios using shielding.
- We can run the code over a greater number of seat choices to try to improve our solution.

Methods and results

Following our discussions, we took the CAD file provided and reformatted the information to be compatible with our app. Upon selecting a fixed desk, the algorithm sweeps through all other seats and removes any desk that is within the social distance measure provided, repeating this process until all available desk spaces have been checked. In order to find an optimal solution, we simulated the desk selection randomly 5000 times (see Figure 1), selecting the order of fixed seats that yielded the greatest capacity. The results of the optimal desk selection algorithm are displayed in Figure 2 and in Table 1. We have run simulations including and excluding the conference room.

	Maximum capacity at 2m social distancing (%)
Next CAD file benchmark	27.9
Cardiff App with conference rooms	43.0
Cardiff App without conference rooms	45.2

Table 1: Comparison of the performance of the Cardiff seat finding app against the benchmark provided in the supplied CAD file.

As demonstrated in Table 1, we can very quickly achieve significantly higher occupancy rates in the office without violating social distancing measures. Given more time, we can search for even better solutions, as well as develop methods for user specification of shield locations (see first app).

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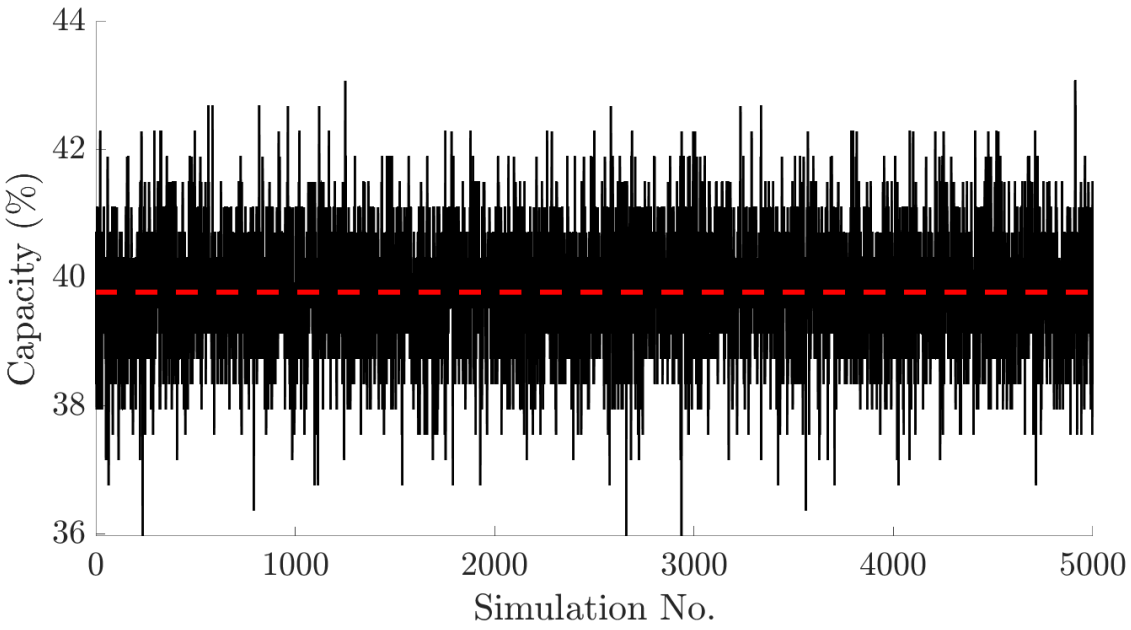
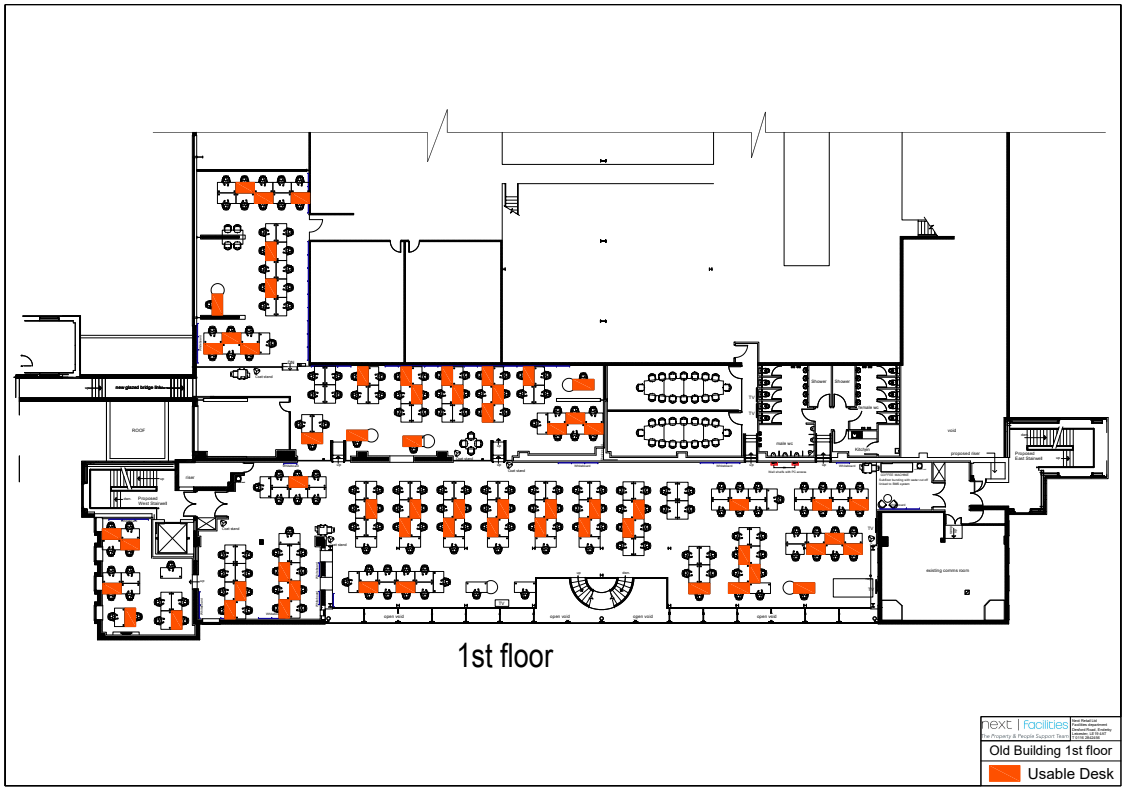


Figure 1: Stochastic layout selection for the old building first floor, not including the conference room. Fixed desks are selected at random, then the algorithm sweeps through all desks and removes those too close to the accepted desks. The black line represents the capacity from each simulation, while the dashed red line corresponds to the mean of all simulations.

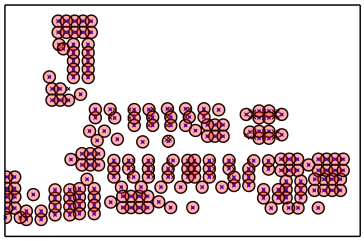
Prospective developments for improving optimality

Our app always provides seating arrangements that obey social distancing measures, and provides locally optimal solutions which are already better than the given benchmarks. Returning the absolute optimum arrangement, however, is a lot more difficult because the problem is what is known as 'NP-hard'. Simply put, the only way to guarantee you have the most possible seats used is to try every possible order of seat checking, and pick the one which has the most seats used. Actually trying out every seat ordering would take a very long time; there are more ways to order 253 seats than there are particles in the universe.

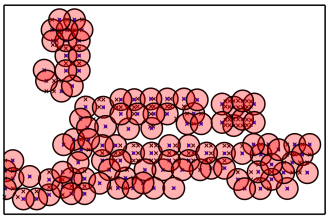
What we can do, though, is develop techniques to check our solutions and continuously improve upon them where possible. At a cost of additional time and computing power to implement, these methods would improve the likelihood we have found the best possible seating arrangement, allowing us to potentially further improve on our already powerful result. For example, we have a provided preliminary calculations in Figure 1 to show that our current results are optimal up to $5,000$ simulations, however, this can extended with computational power and theoretical applications.



(a) The seating arrangement given as an example in the CAD file, for reference.



(b) A sample layout for a social distancing measure of 1 metres, which uses 201 seats.



(c) A sample layout for a social distancing measure of 2 metres, which uses 105 seats.

Figure 2: A proposed office layout given by the app for 1 and 2 metre social distancing. Seat locations are marked with crosses, available seats are marked with dots and the 'region of safety' is denoted by a circle around the available seats. Overlapping circles imply that certain regions are exposed to contamination from multiple sources, but no available seats are located in these regions.