Elevator Simulation

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This is a group project for my class CS166: Modeling, Simulation and Decision Making

We implemented two strategies. As seen in the code, one is called “shabbat” and the other one “ordinary”.

- The “shabbat” strategy: The elevator starts on the ground floor and move all the way to the top floor and when it reaches the top floor, it changes direction and moves to the ground floor, stopping at every floor in between. At every stop, the elevator will take in and drop-off passengers based on their requests, given that the number of passengers do not exceed the elevator capacity. The elevator repeats the cycle of moving up and down until all passengers are delivered to their destinations.
- The “ordinary” strategy: The elevator also starts on the ground floor, and it will take on request that leads it to the closest floor in the direction of movement. If there are no requests in the direction of movement, the elevator changes its direction. For passengers in the elevator, the request would be their destination floor, and for passengers outside of the elevator, the request would be their pick-up floor. The elevator continues to move until it finishes delivering all the passengers to their destinations.

How we measure the efficiency of a strategy:

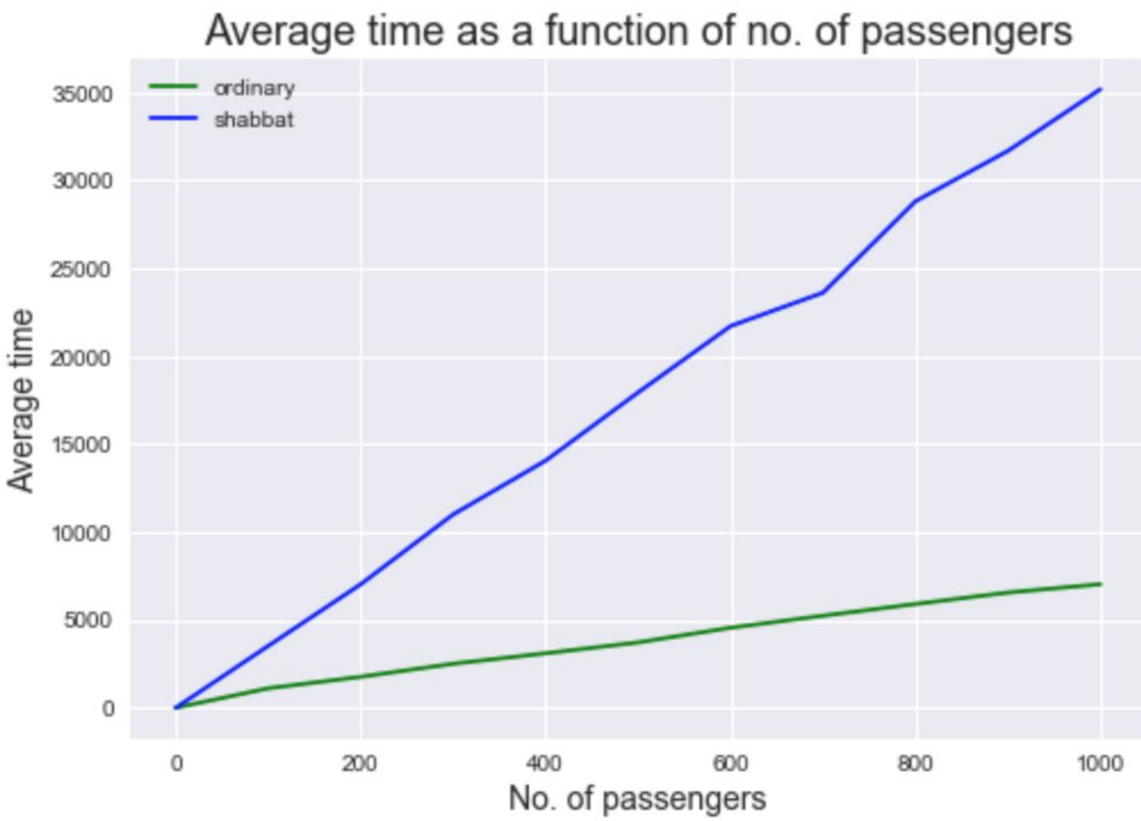
We measure the efficiency of a strategy by computing the average journey time of each passenger. The journey starts when a button is pressed (in this case we assumed all passengers pressed the buttons at the same time because all the requests were simultaneously), and it ends when a destination is reached.

We assume that it takes 1.5 seconds for the elevator to move between floors and it takes 6 seconds in total every time the elevator makes a stop (1.5 seconds for door to be closed, 1.5 seconds for door to be opened, 3 seconds for passengers to get on/off the elevator).

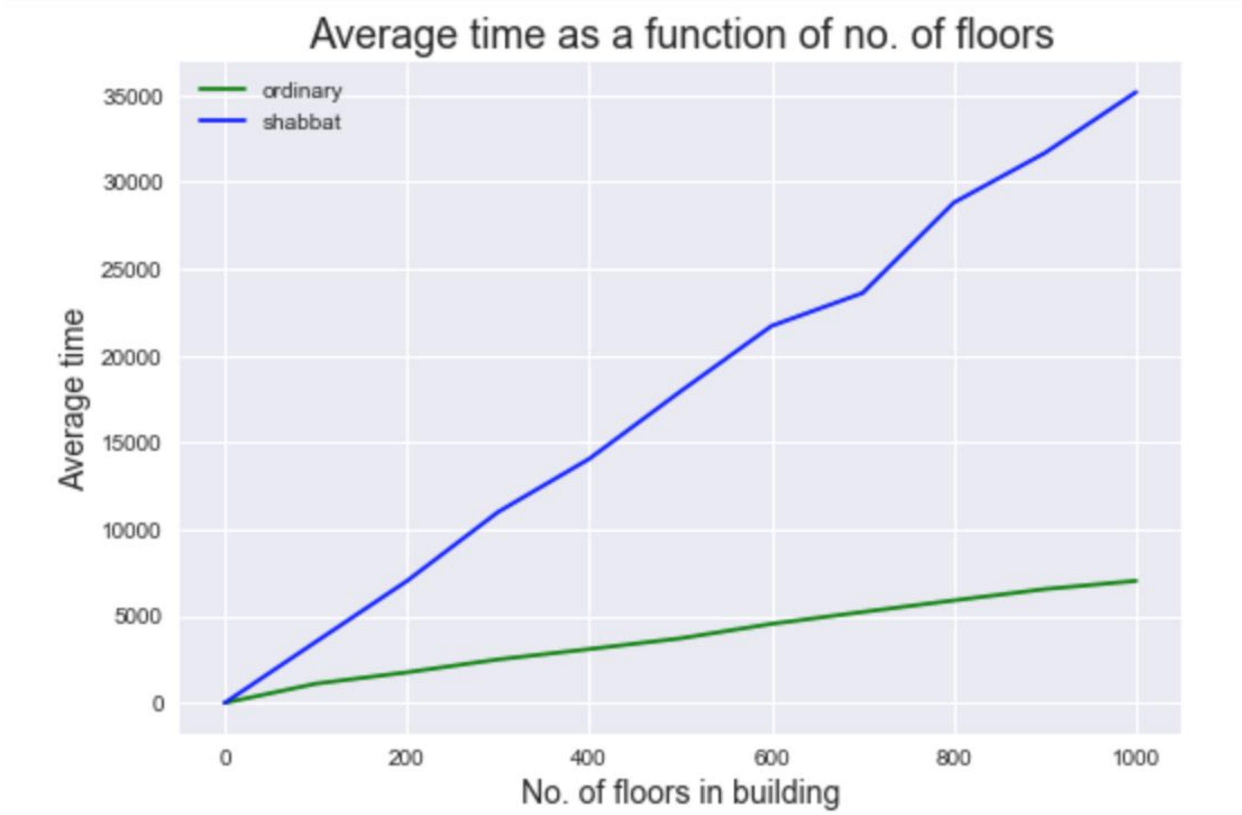
The average journey time of each passenger is calculated by dividing the total time it takes for one simulation by the total number of passengers.

How we compare different strategies:

We compare the two strategies by running the simulation multiple times for each parameter value and calculate the average. First, we want to see how the two strategies compare as the number of passengers increase. We can see from the first graph below that the “shabbat" strategy takes more time on average compared to the “ordinary" strategy. And the gap keeps increasing when we increase the number of passengers.



We also want to compare the two strategies when the number of floors increase. By increasing number of floors, we introduce higher cost for the Shabbat elevator because it stops at every floor.



In both cases, we see that the “ordinary” elevator clearly outperforms the “shabbat” elevator. This result is quite predictable because while the “shabbat" elevator stops at every floor no matter what, the “ordinary" elevator only stops at floors based on the requests. This increases the stop time of the “shabbat" elevator (as we assume it takes 6 seconds to make a stop). Also, the “shabbat" elevator is only able to change its direction when it reaches the top floor, which may introduce more unnecessary traveling time when there are no remaining requests on that direction.

Some assumptions:

The calculations above based on how much time we assign for each operation of the elevator. As mentioned, we assume that it takes 1.5 seconds for the elevator to move between floors and it takes 6 seconds in total every time the elevator makes a stop, which is more costly. This assumption is quite realistic based on how we observe an elevator performs in real life.

Originally, when we assign passengers totally randomly to different floors, we saw no significant difference in efficiency of the two strategies. This is because the passengers will be equally likely coming and going to floors across the whole building, so the fact that the “shabbat" elevator only changes direction when it reaches the highest floor doesn't waste as much time. After that, we decided to make the simulation more realistic by assuming that passengers will more likely come

from and want to go to the base floor/ lobby (which is floor 0 in our case). Given this assumption, the “ordinary" strategy seems to work better on average.
Also, we assume that the elevators know all the requests before it starts moving. Even though this helps simplify things a lot, it is not very realistic. I wish we could explore this scenario if we had more time.