Football Stadium

194.076 Modeling and Simulation W2023

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Problem Definition

6000 Fans expected to attend the soccer game.
The first fans arrive 2 hours before kickoff.
40% of the fans hold a season ticket
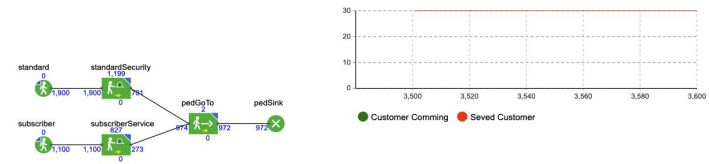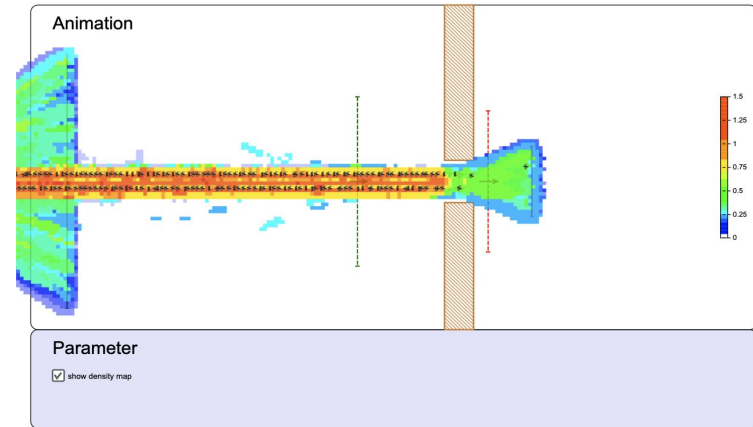Security check takes 6±3 seconds for standard fans and 3±1 seconds for season ticket holders

Model Scaling

Because of AnyLogic Version Issues we were not able to simulate longer than 1 hour. Therefore we scaled the visitors.

- 3000 Fans expected (Ultras included)
- Serving Times stay the same
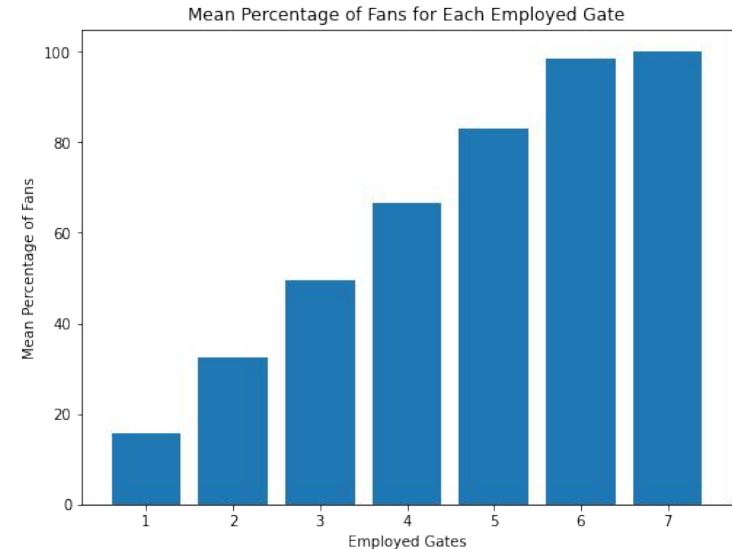- Kickoff at Minute 50

Task 1 - Find the optimal number of gates

- We have a total of 3000 expected fans
- We should ensure that at least 99% inside the stadium
- Inter-arrival time for standard customers/subscribers (= 1.6 / 2.2 sec.) → on average standard customers/subscribers arrive every (1.6 / 2.2 sec.)
- Each agent has a velocity & movement radius that is uniformly distributed
- We selected passion distribution which captures the nature of crowd behavior
- Monte Carlo employed in a run CSV file 10 Simulation for each gate

Animation

Parameter

☑ show density map

standard
standardSecurity
pedGoTo
pedSink

subscriber
subscriberService

Result Task 1 optimal number of Gates

Employed Gates	x̄ number of fans	x̄ percentage of fans
1	468.2	15.607 %
2	972.5	32.416 %
3	1489.8	49.660 %
4	1996.3	66.544 %
5	2485.6	82.853 %
6	2951.8	98.394 %
7	3000.0	100.000 %

Mean Percentage of Fans for Each Employed Gate

Task 2 - Ultras coming as group

- We injected 250 Ultras at minute 25 (scheduled event)
- Treated as standard Users
- Last Ultra arrived 2 minutes before kickoff (average)

https://drive.google.com/file/d/1Ion8n2rnHYum5XwuGvltC5UxHZkcZ3
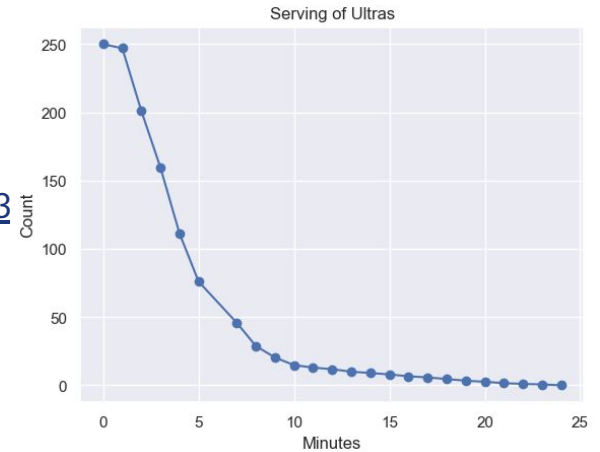
Task 3 - 2000 fans more than expected

- mean after 10 runs:
  on average last fan enters 20 minutes (1221.9 s) after kick-off
- still large crowd at gates at kickoff time

Model results after 2 hours runtime:
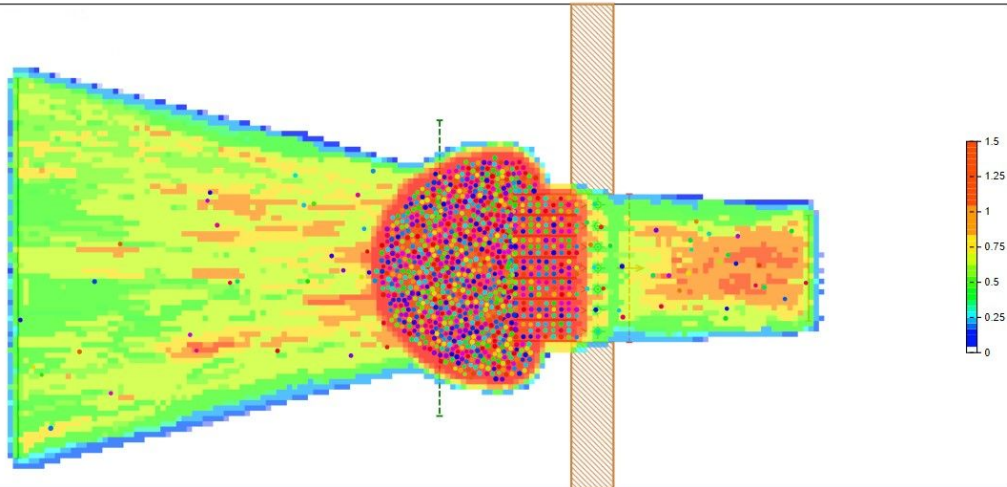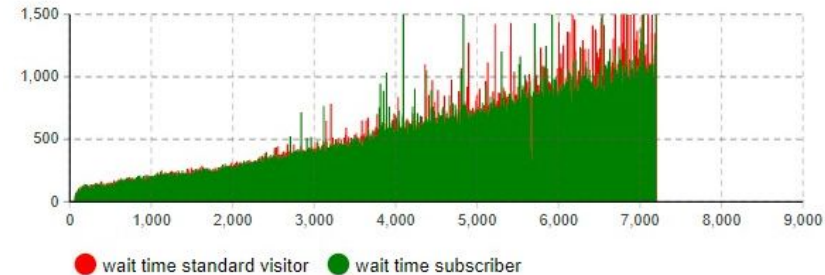
↻→ visitorsArrived
7,926

↻→ meanCheckInsPerHour
3,474.426

↻→ visitorsInStadium
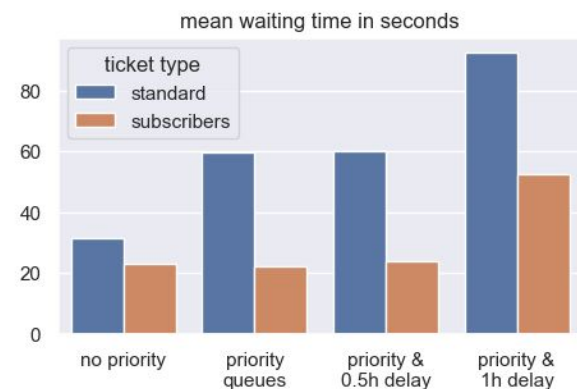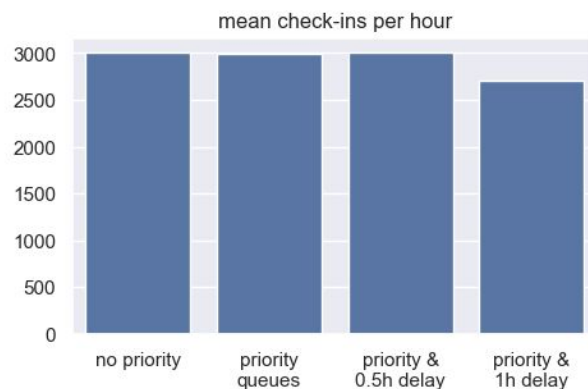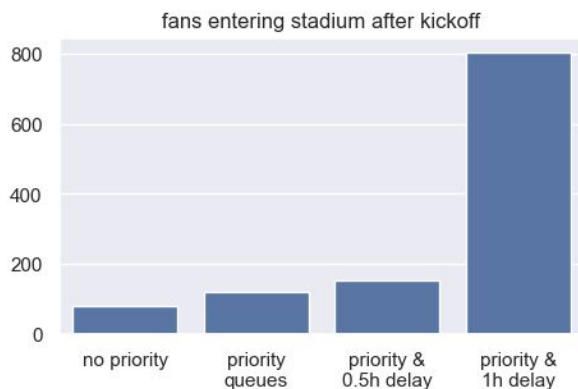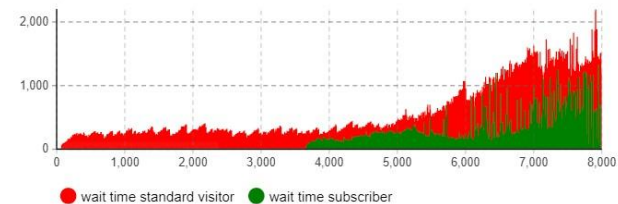6,838

↻→ meanWaitTimeStandard
185.871

↻→ lastVisitorEntered
0

↻→ meanWaitTimeSubscriber
141.954

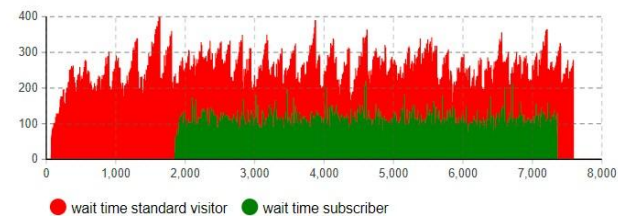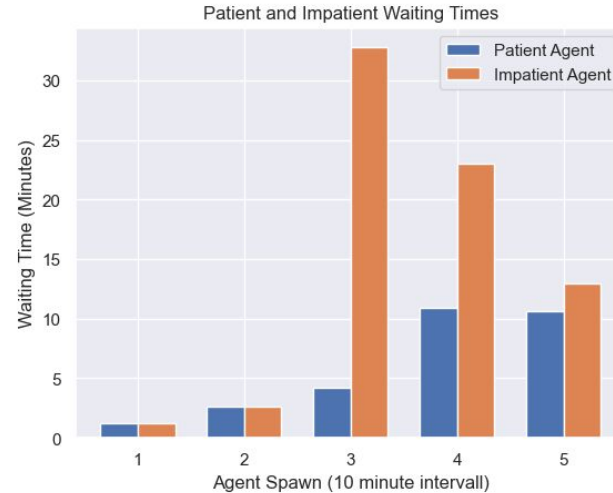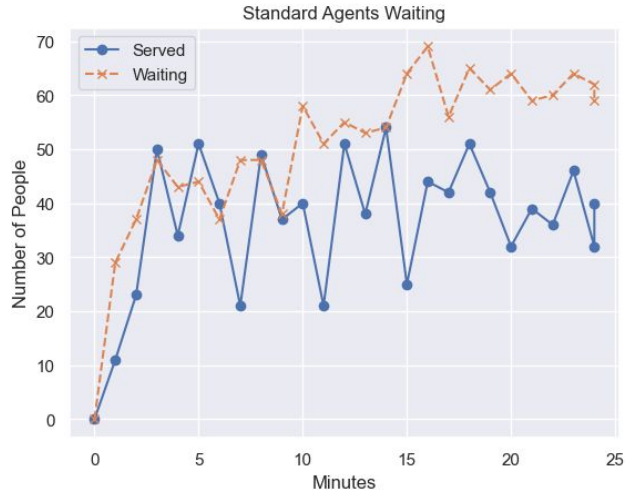● wait time standard visitor   ● wait time subscriber

Task 4 - Preferred treatment

- 2 queues reserved for season ticket holders
- taking advantage: season ticket holders arrive earliest 1.5h or 1h before kickoff
- standard tickets have almost double the waiting time
- only with 1h delay there is a significant difference also for season ticket holders

wait time standard visitor ● wait time subscriber

wait time standard visitor ● wait time subscriber

fans entering stadium after kickoff

mean check-ins per hour

mean waiting time in seconds

Task 5 - Switching Lanes Strategy

- Is it true that staying in one queue is faster than switching between lines?
- Spawn an impatient Agent all 10 Minutes (last: 10 Minutes before kick off)

Standard Agents Waiting

Patient and Impatient Waiting Times

Task 5

https://drive.google.com/file/d/1TbOM144tkto5AHbFCQSd0E6LWNqS7SSI/view?usp=sharing

Future Work

- Simulate the Experiment without software version restrictions
- Split the standard fans in two groups of different waiting strategies
- Experiment with different stadium entries according to the seatplaces

Thank You