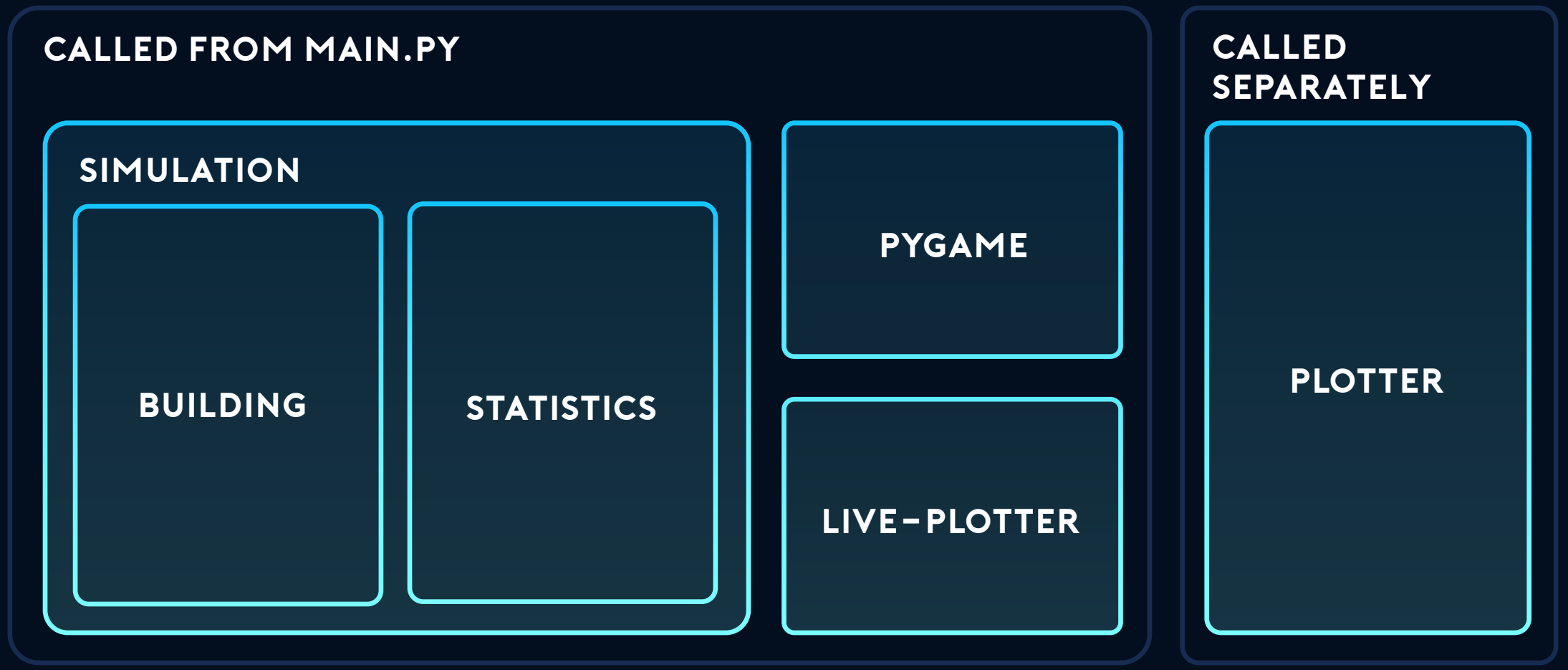
ELEVATING EFFICIENCY

AN ELEVATOR SIMULATION

By Brian Funk, Andrin Gasser and Silvan Metzker

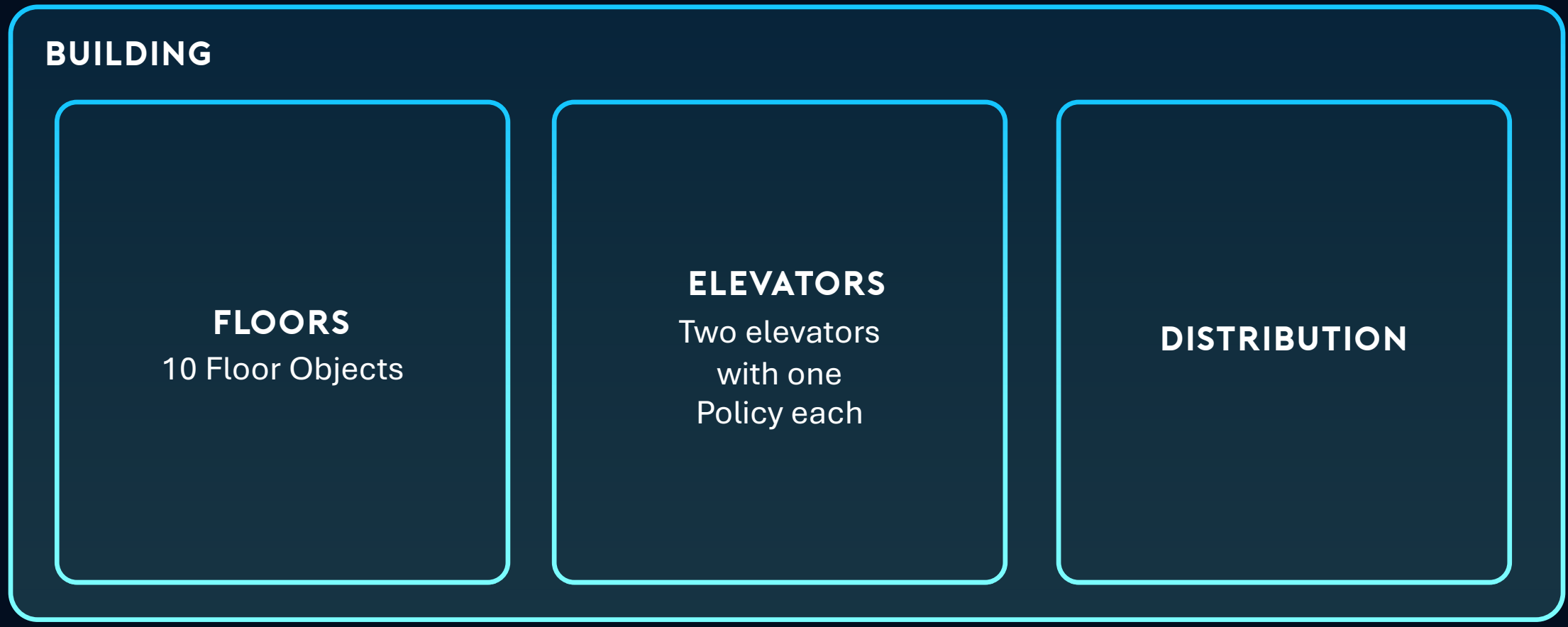
SIMULATION

CODE STRUCTURE



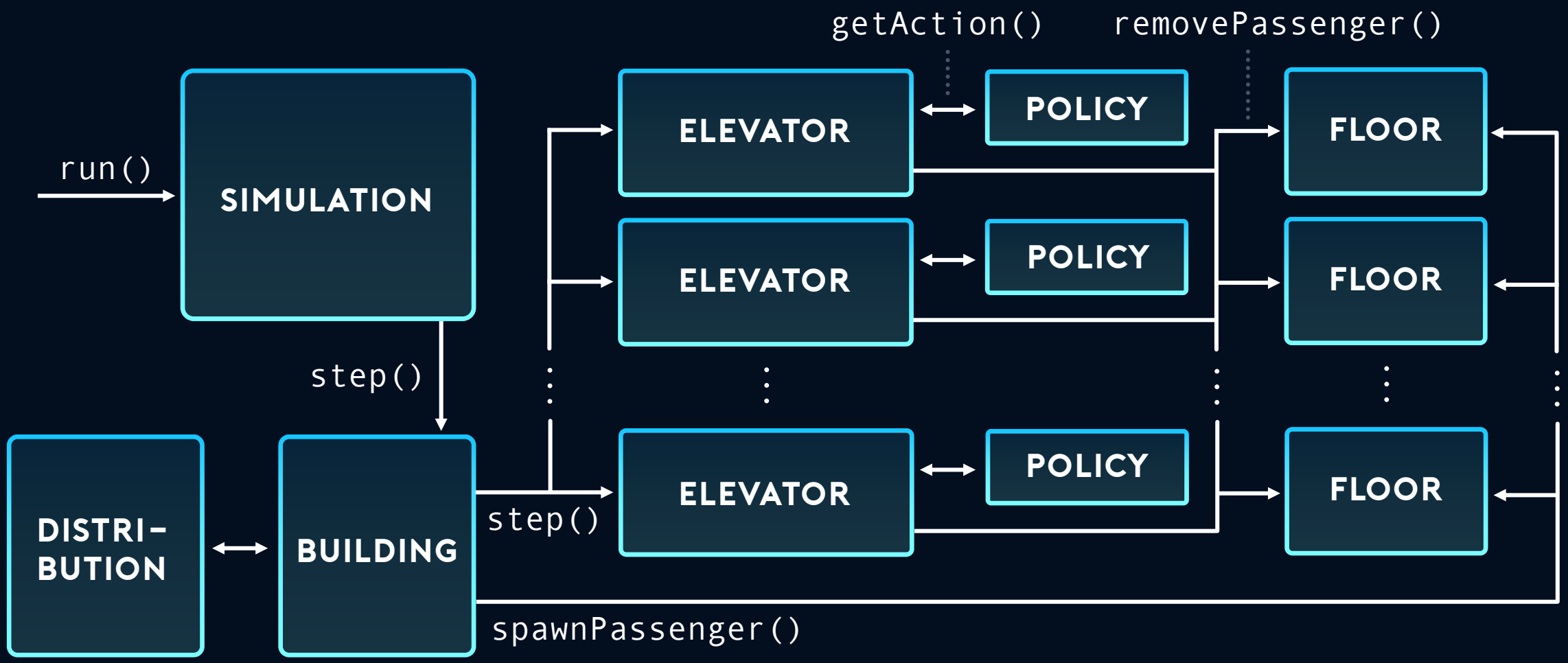
SIMULATION

BUILDING



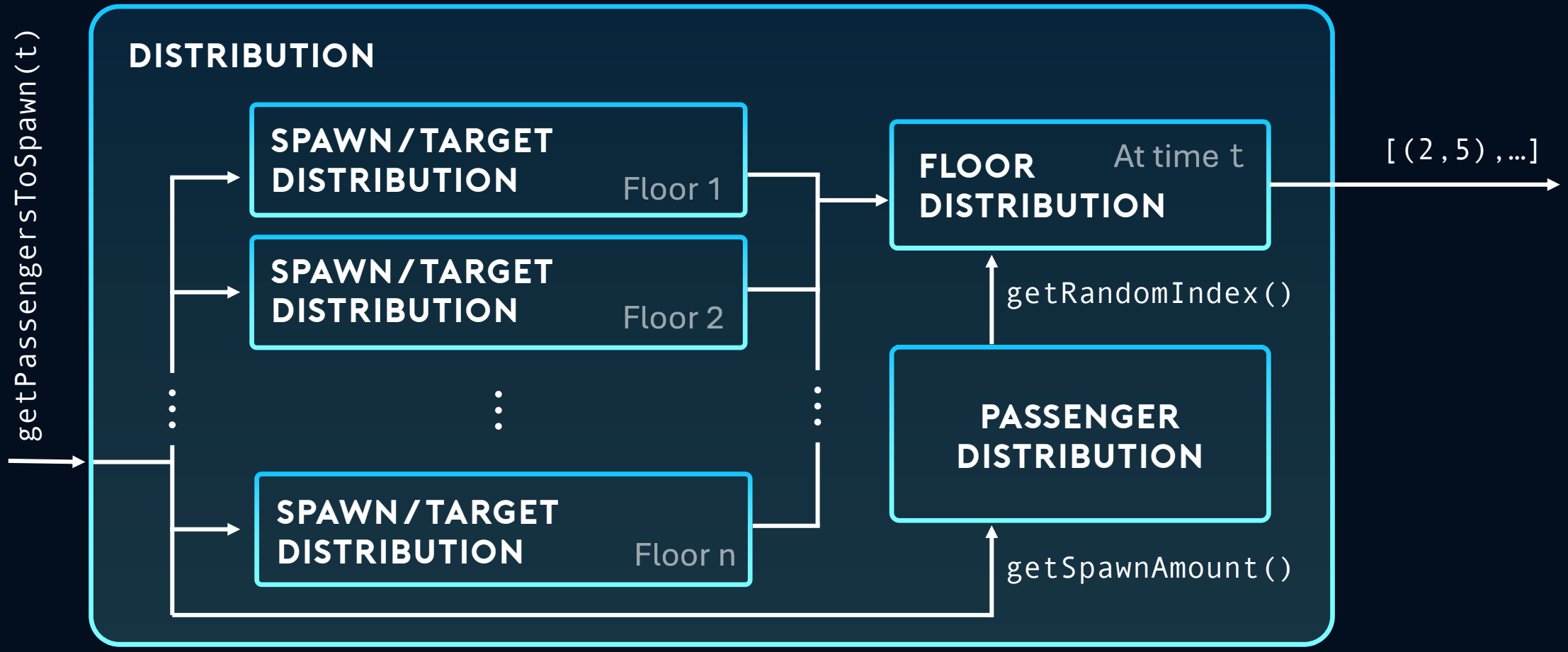
SIMULATION

EXECUTION FLOW



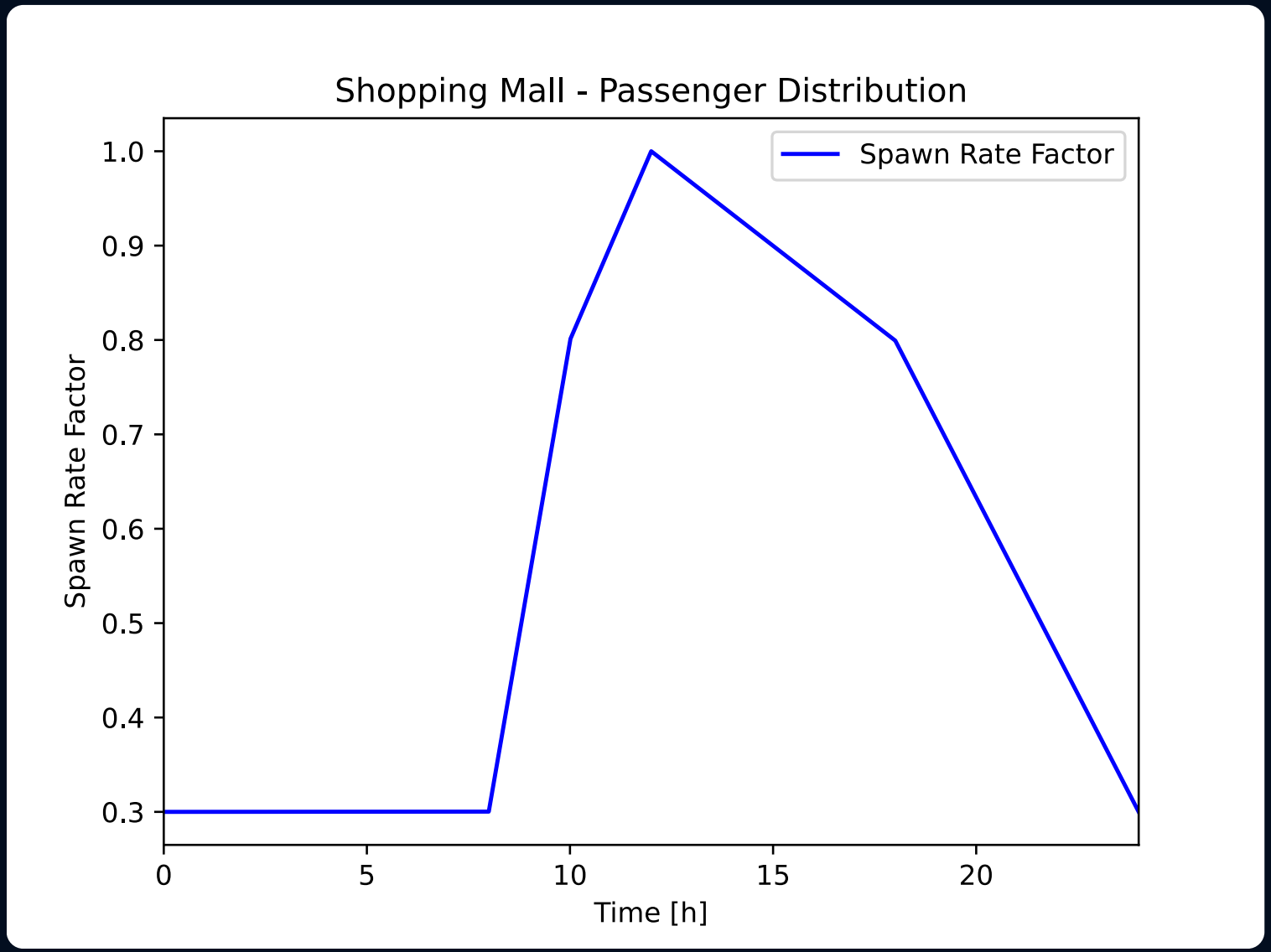
DISTRIBUTIONS

STRUCTURE



SCENARIOS

SHOPPING MALL

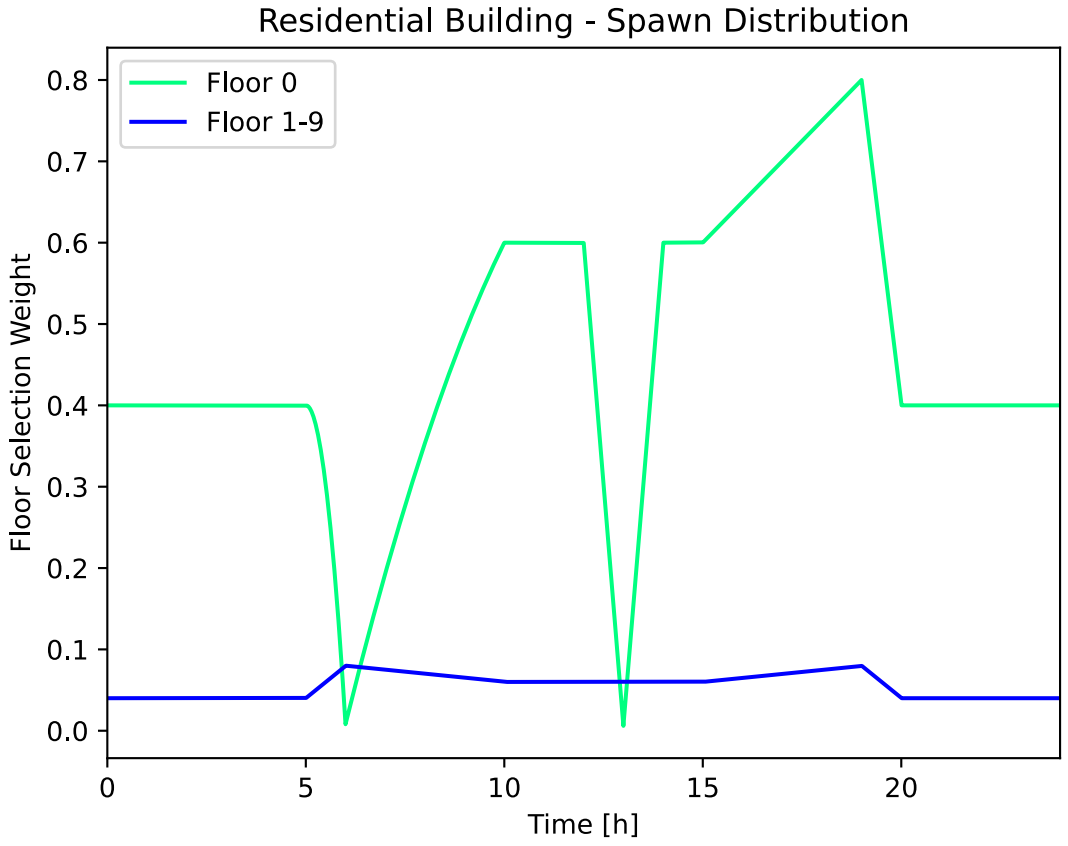

Shopping Mall - Passenger Distribution
Spawn Rate Factor
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
Spawn Rate Factor
0
5
10
15
20
Time [h]

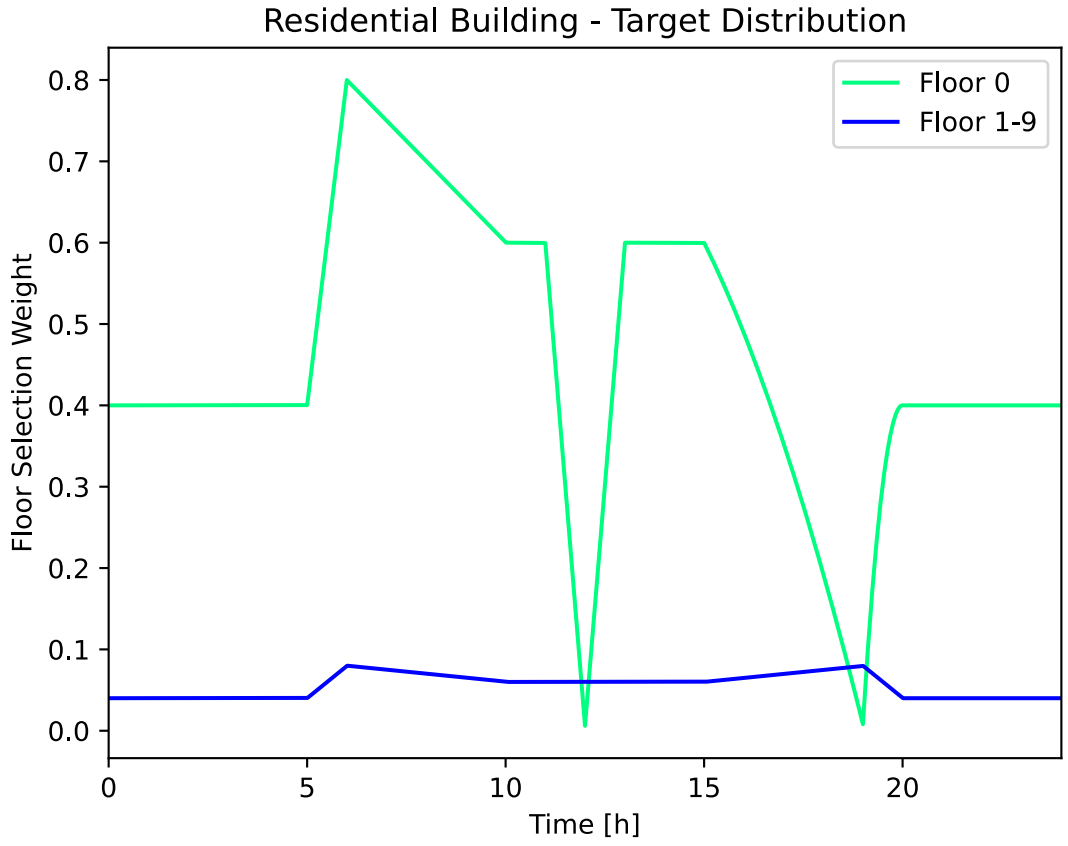
SCENARIOS

RESIDENTIAL BUILDING

SCENARIOS

RESIDENTIAL BUILDING



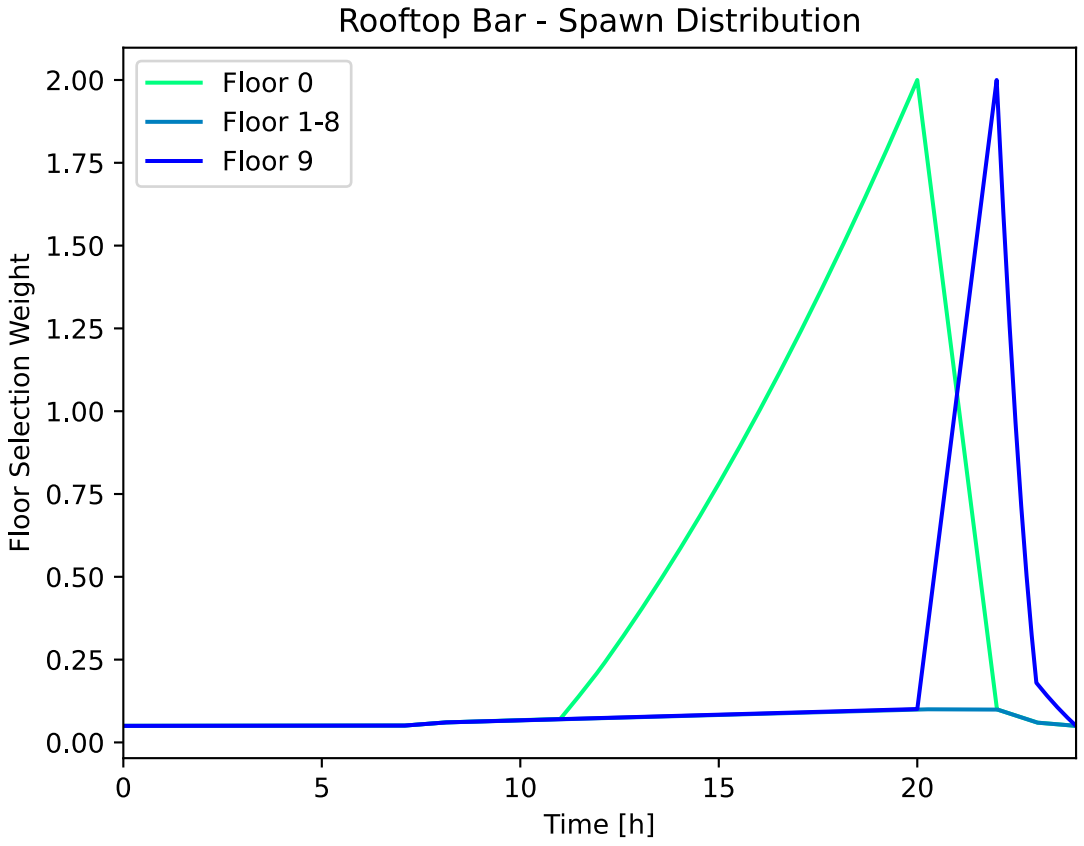


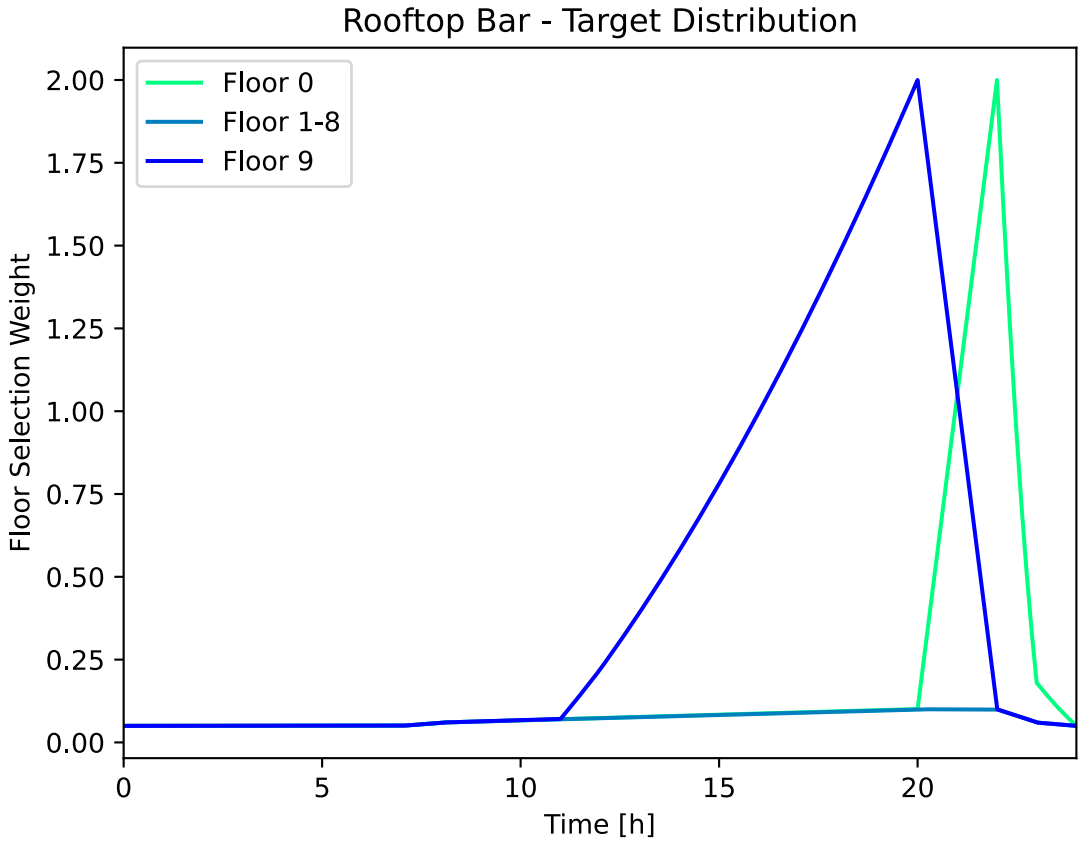
SCENARIOS

ROOFTOP BAR

SCENARIOS

ROOFTOP BAR





POLICIES

POLICIES

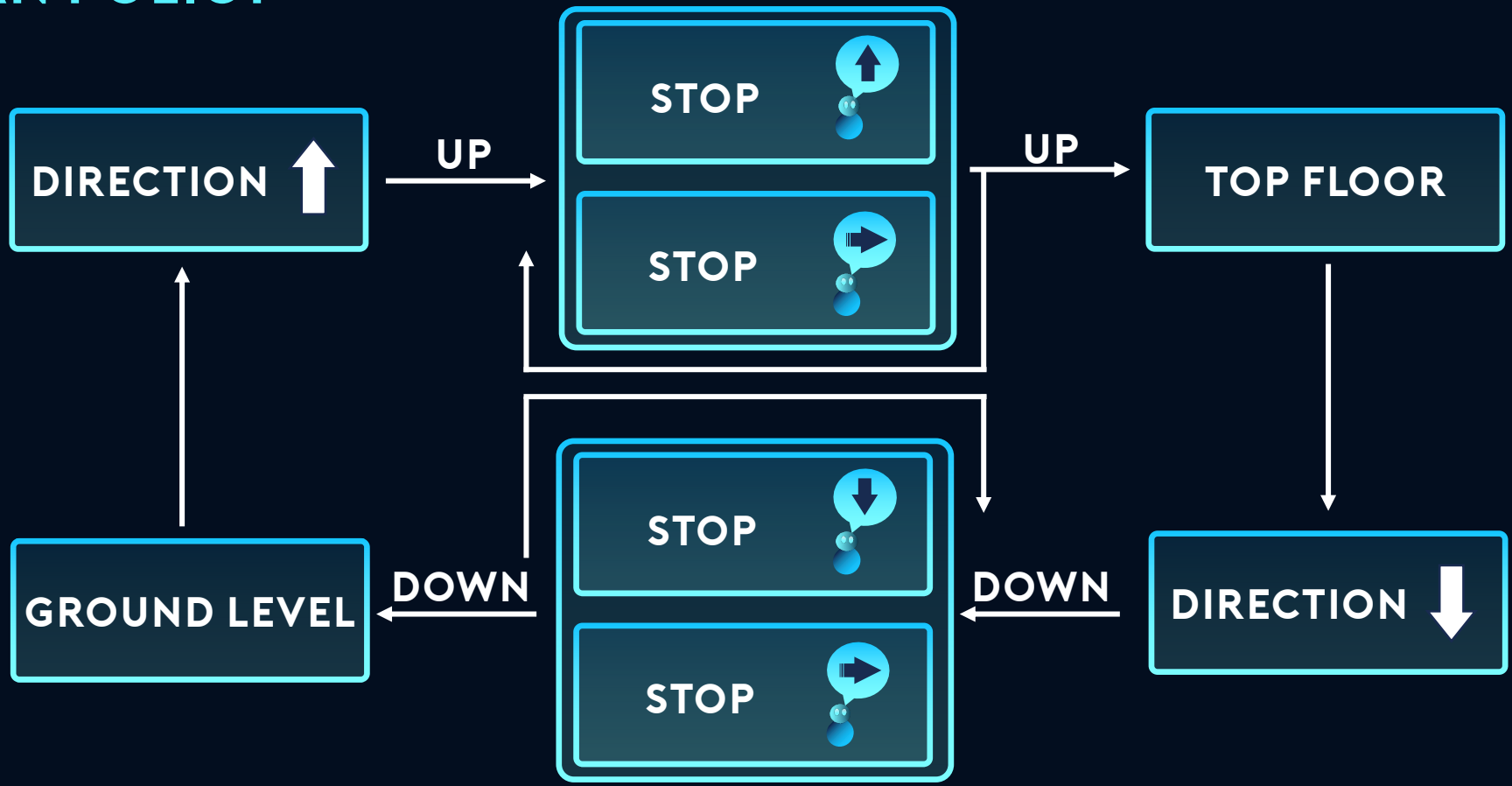
AVERAGE WAITING TIME

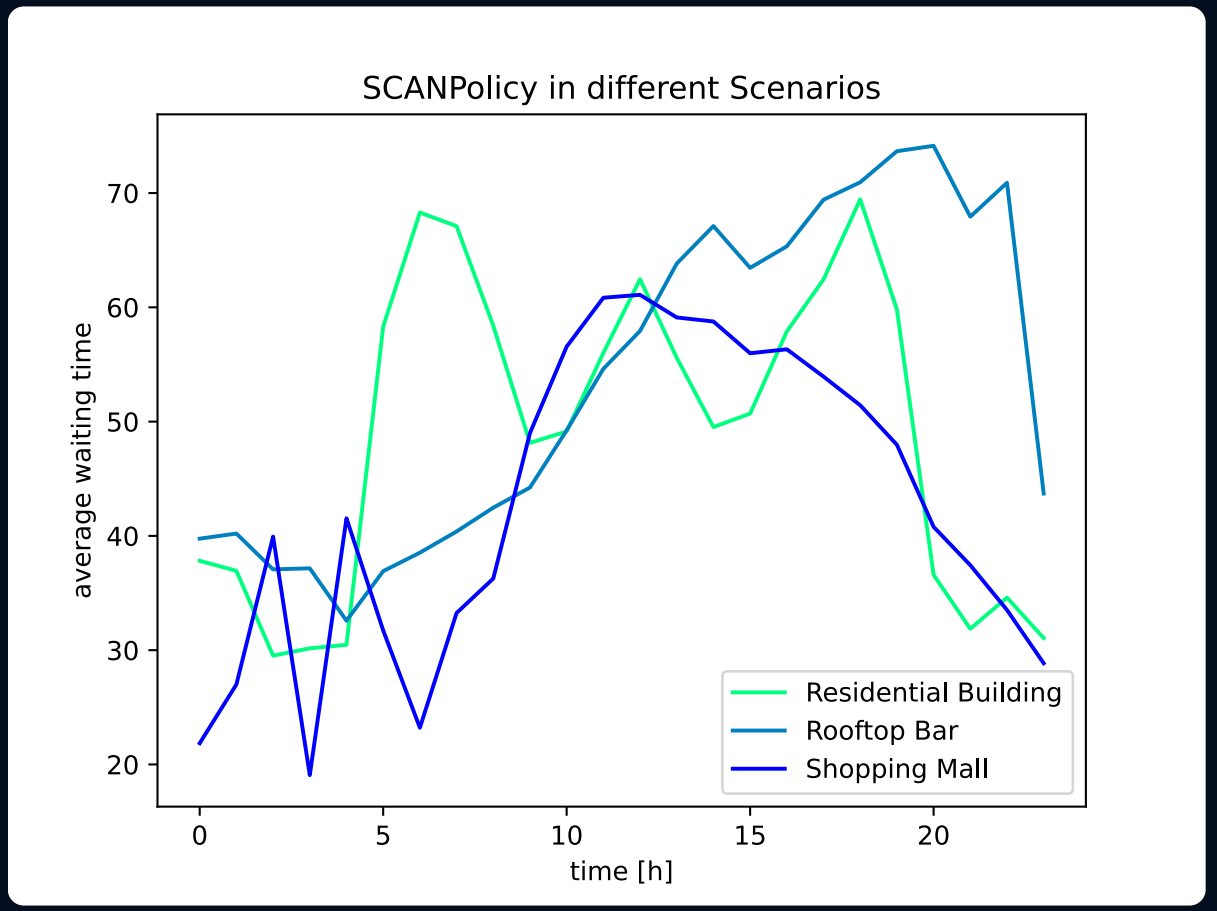
[…] ‘passenger-centric’ parameters are becoming more widely used. The most popular of those are waiting time (sometimes used on its own) or waiting time and travelling time (with equal weighting or with extra weighting to the waiting element). These provide a much better representation of the performance of these modern systems […]

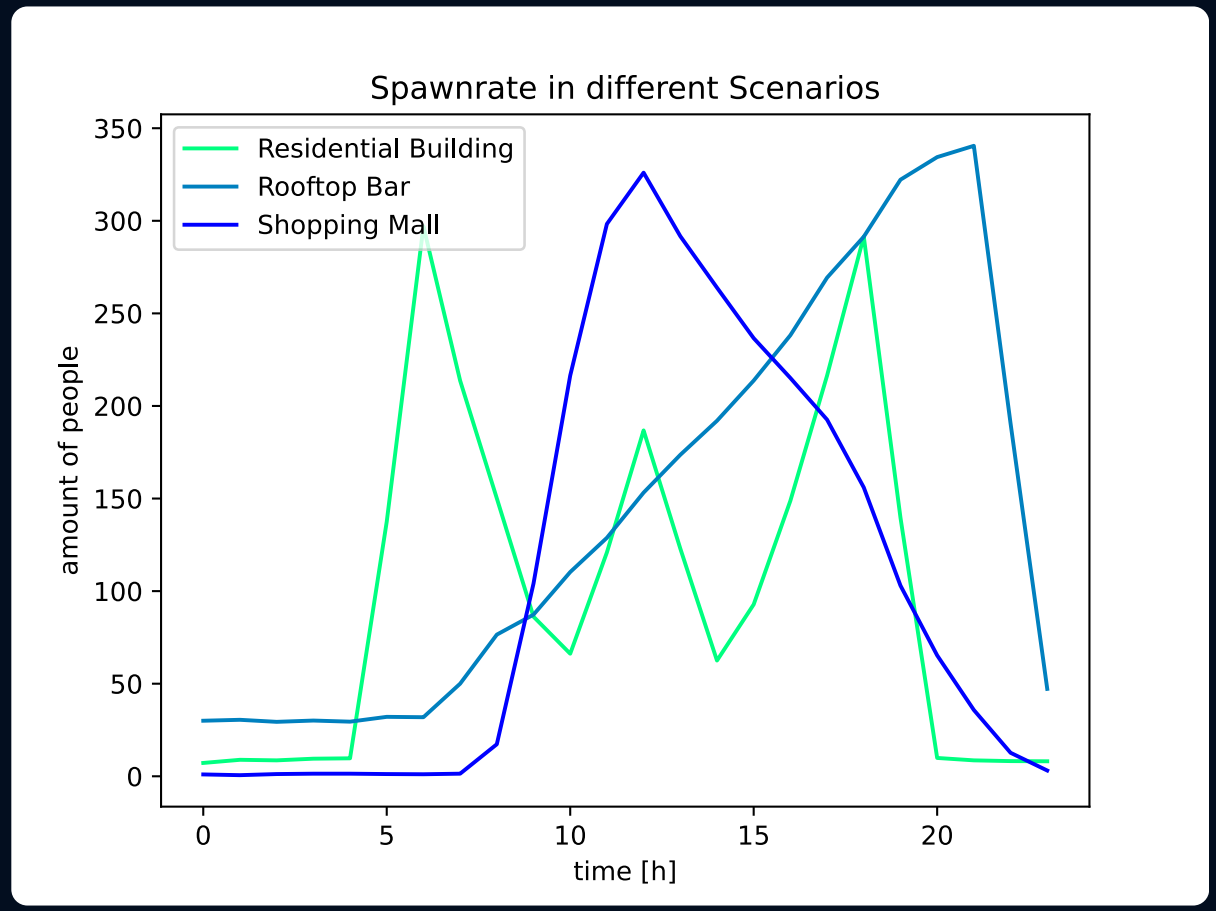
Lutfi Al-Sharif, (2015) The Average Waiting Time and the Average Travelling Time (METE VII), pp. 15

POLICIES

SCAN POLICY




SCANPolicy in different Scenarios
average waiting time
time [h]
Residential Building
Rooftop Bar
Shopping Mall

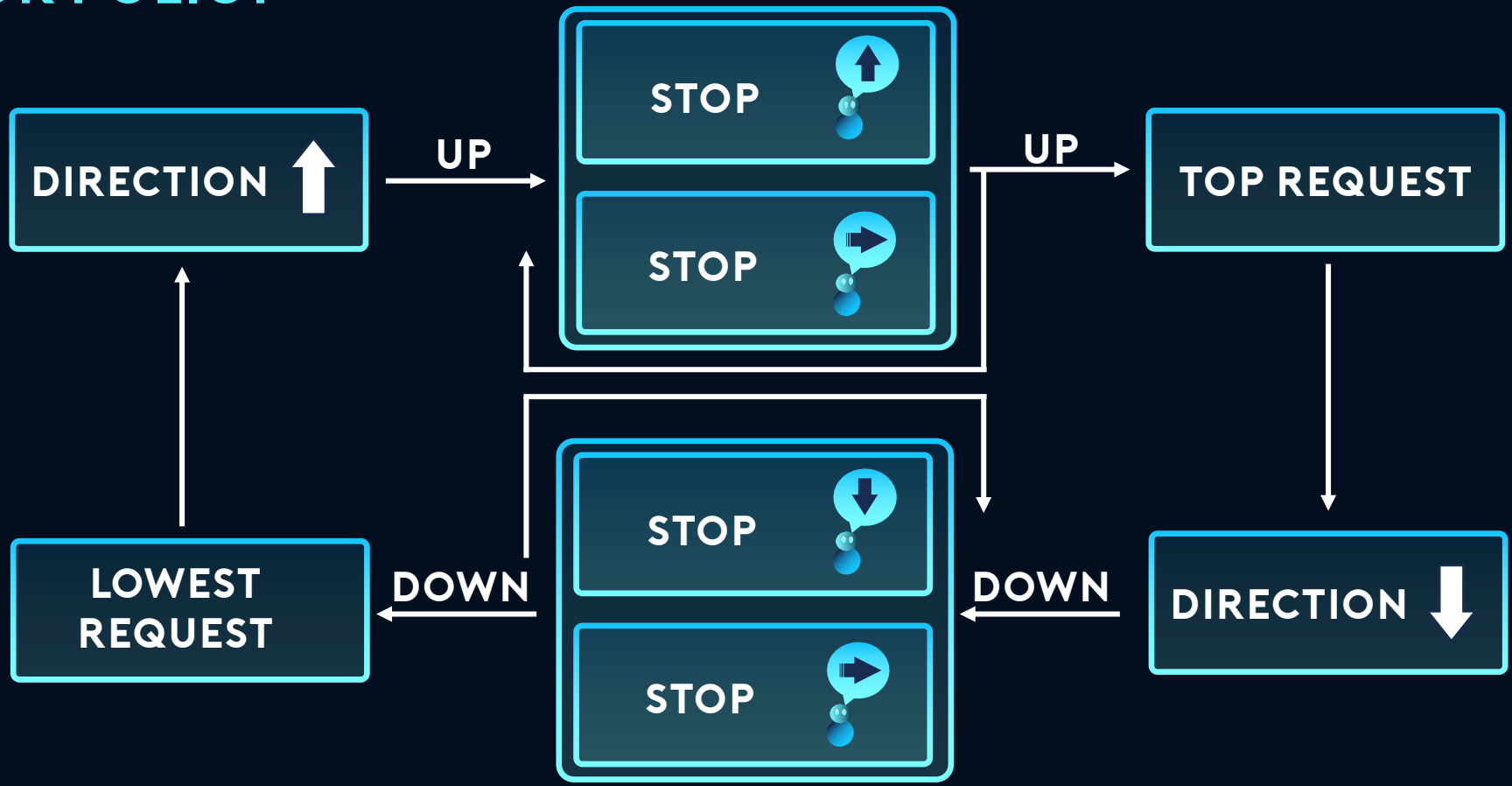

Spawnrate in different Scenarios
amount of people
time [h]
Residential Building
Rooftop Bar
Shopping Mall

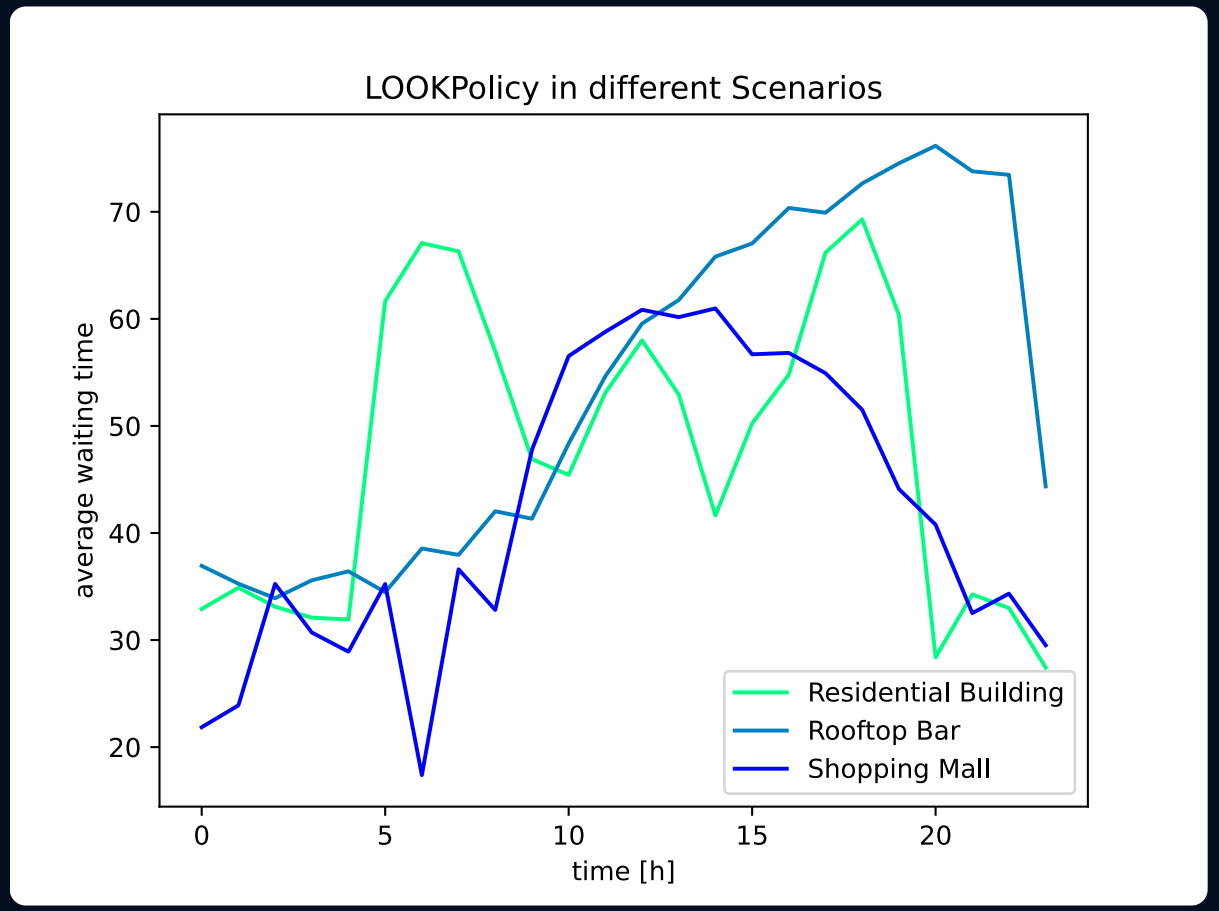
LIVE DEMO

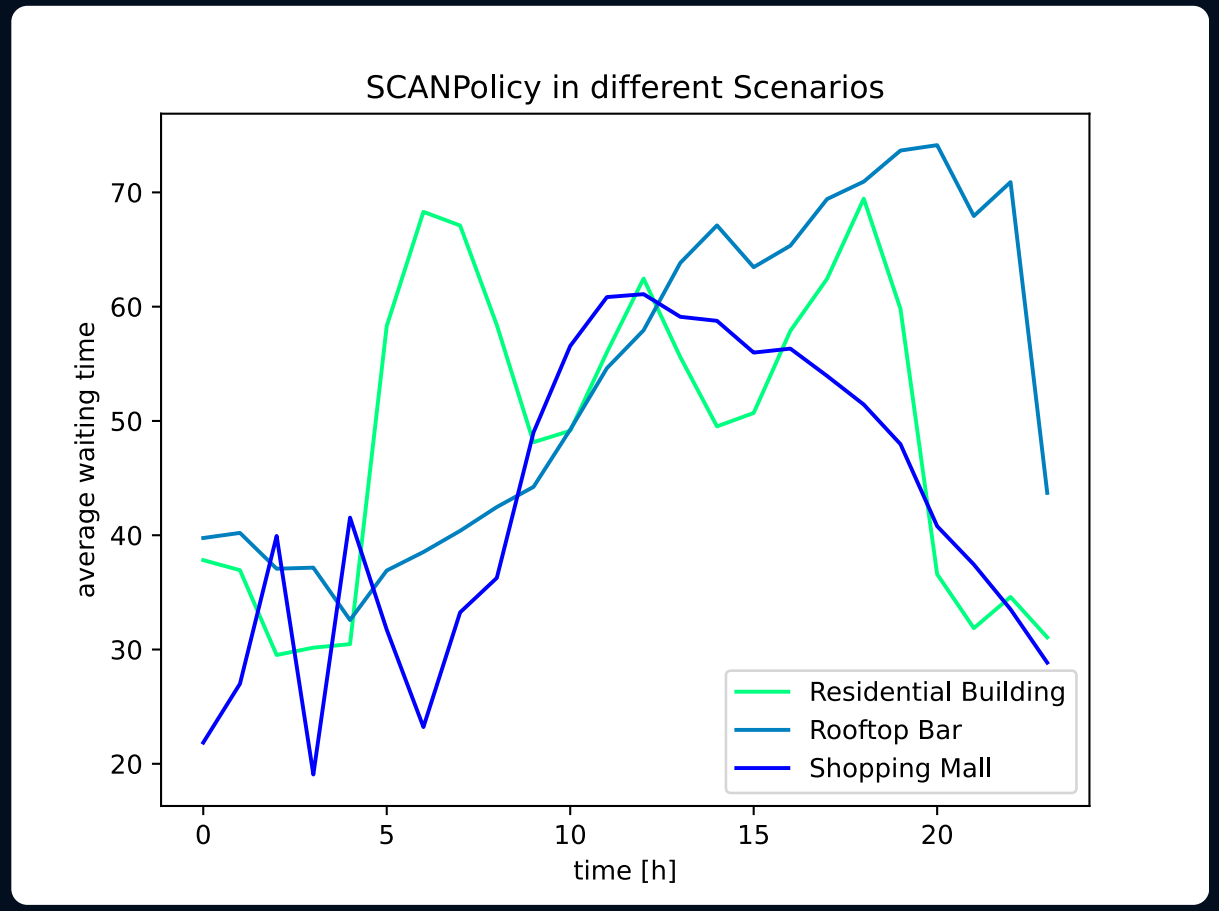
SCAN POLICY

POLICIES

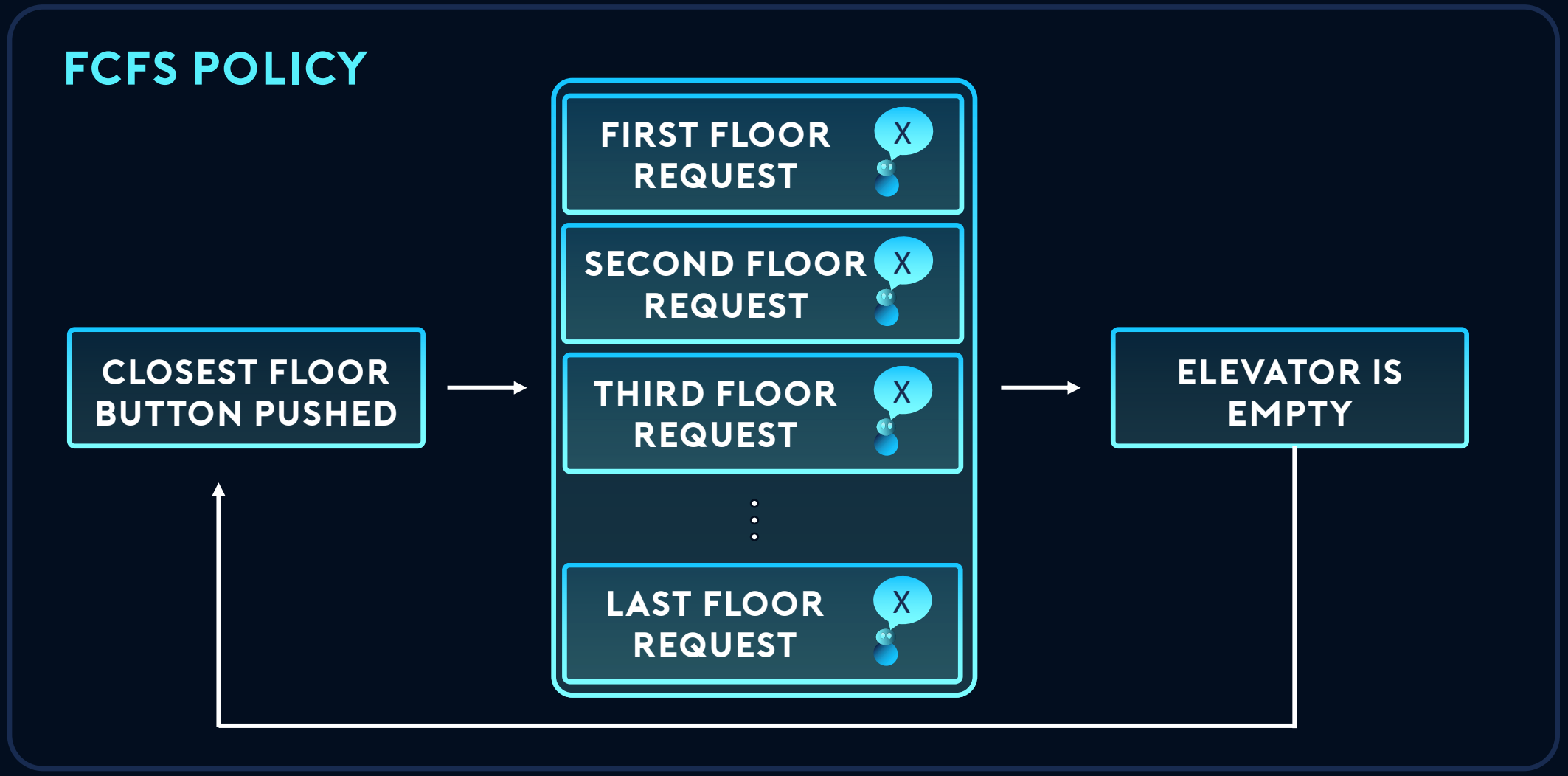
LOOK POLICY

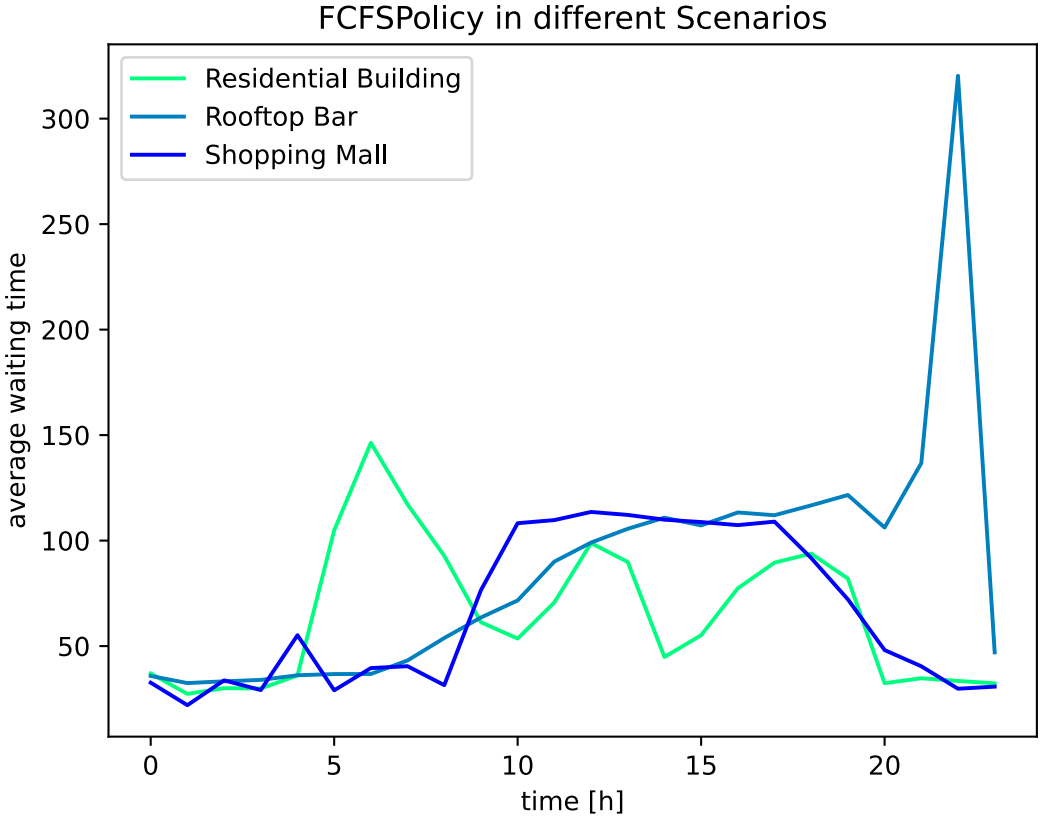


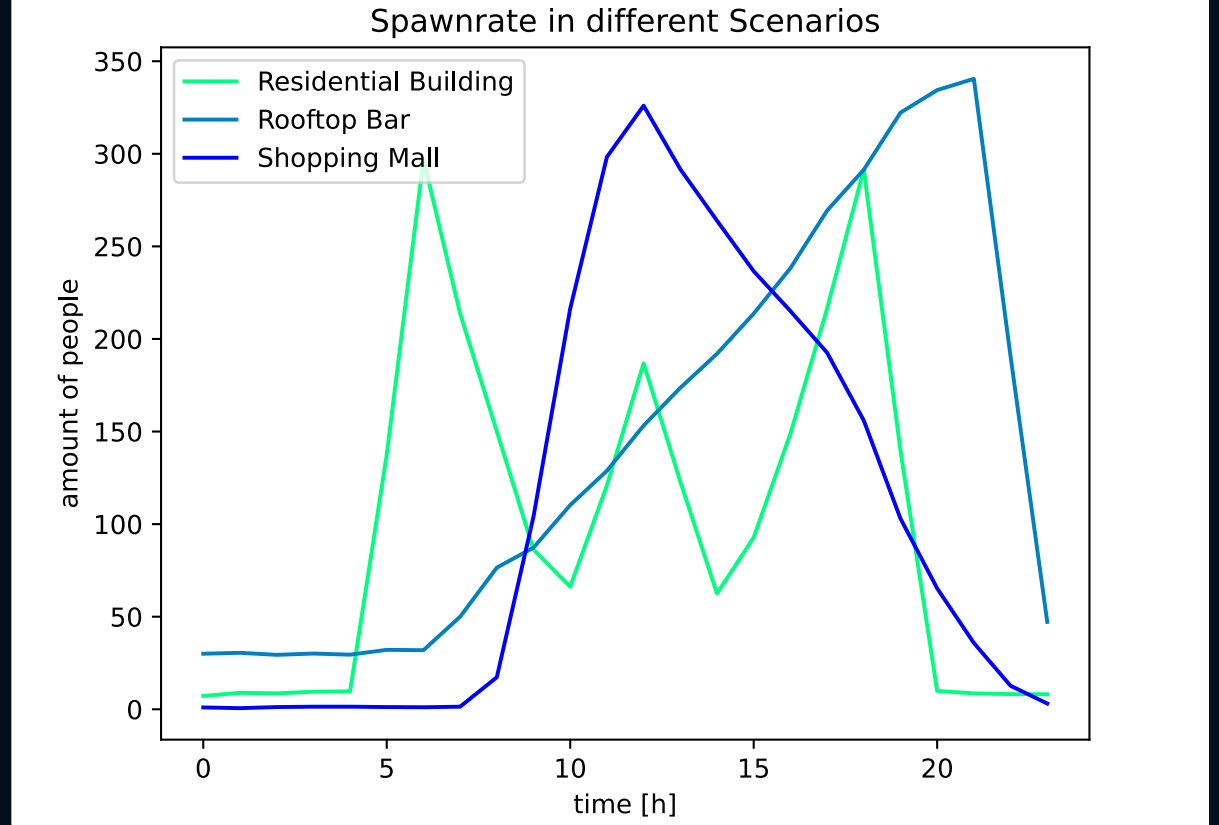

LOOKPolicy in different Scenarios
average waiting time
time [h]
Residential Building
Rooftop Bar
Shopping Mall


SCANPolicy in different Scenarios
average waiting time
time [h]
Residential Building
Rooftop Bar
Shopping Mall

POLICIES


FCFS POLICY
CLOSEST FLOOR BUTTON PUSHED
FIRST FLOOR REQUEST
X
SECOND FLOOR REQUEST
X
THIRD FLOOR REQUEST
X
LAST FLOOR REQUEST
X
ELEVATOR IS EMPTY

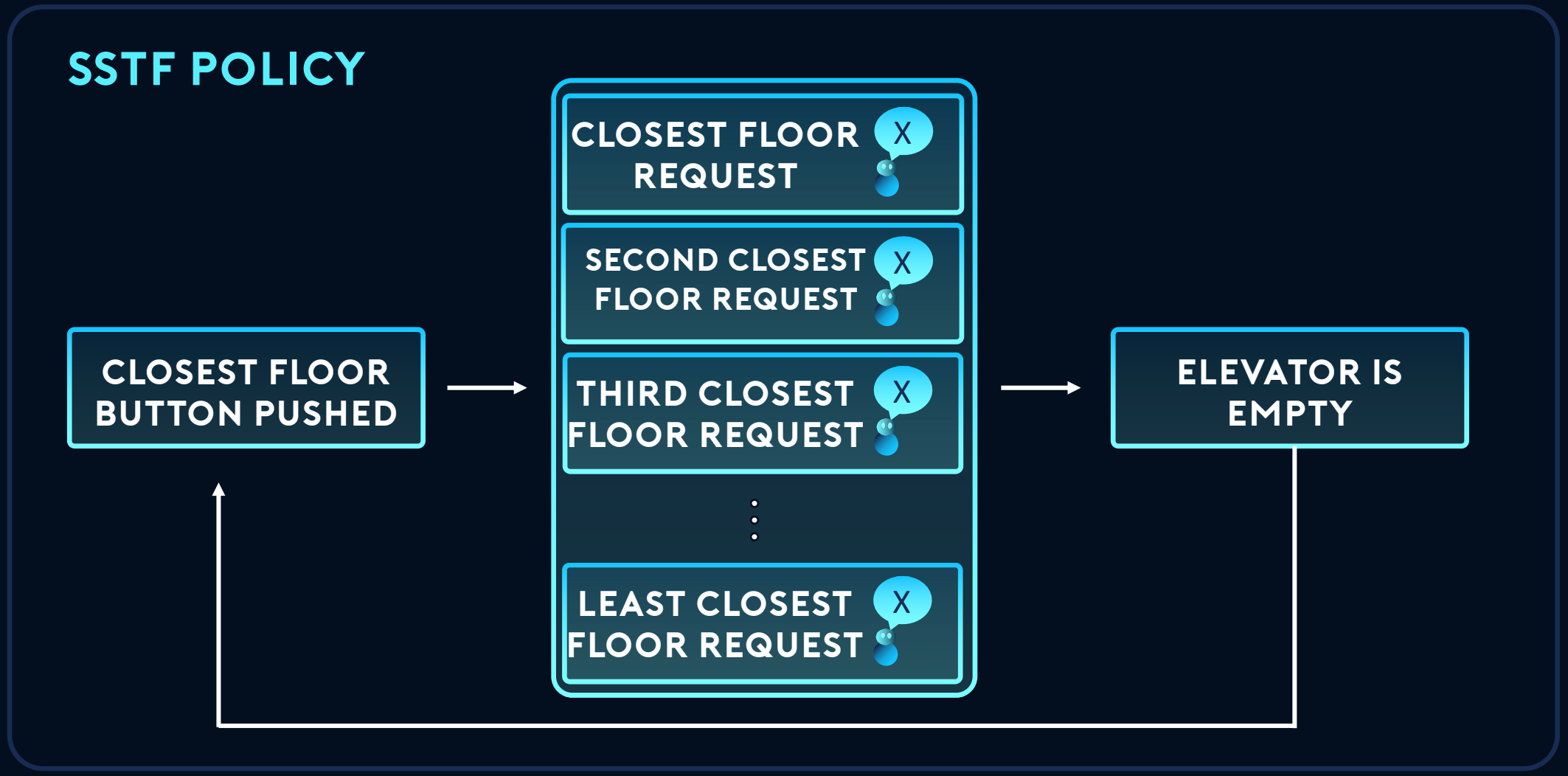

FCFSPolicy in different Scenarios
Residential Building
Rooftop Bar
Shopping Mall
average waiting time
time [h]
0
5
10
15
20
50
100
150
200
250
300

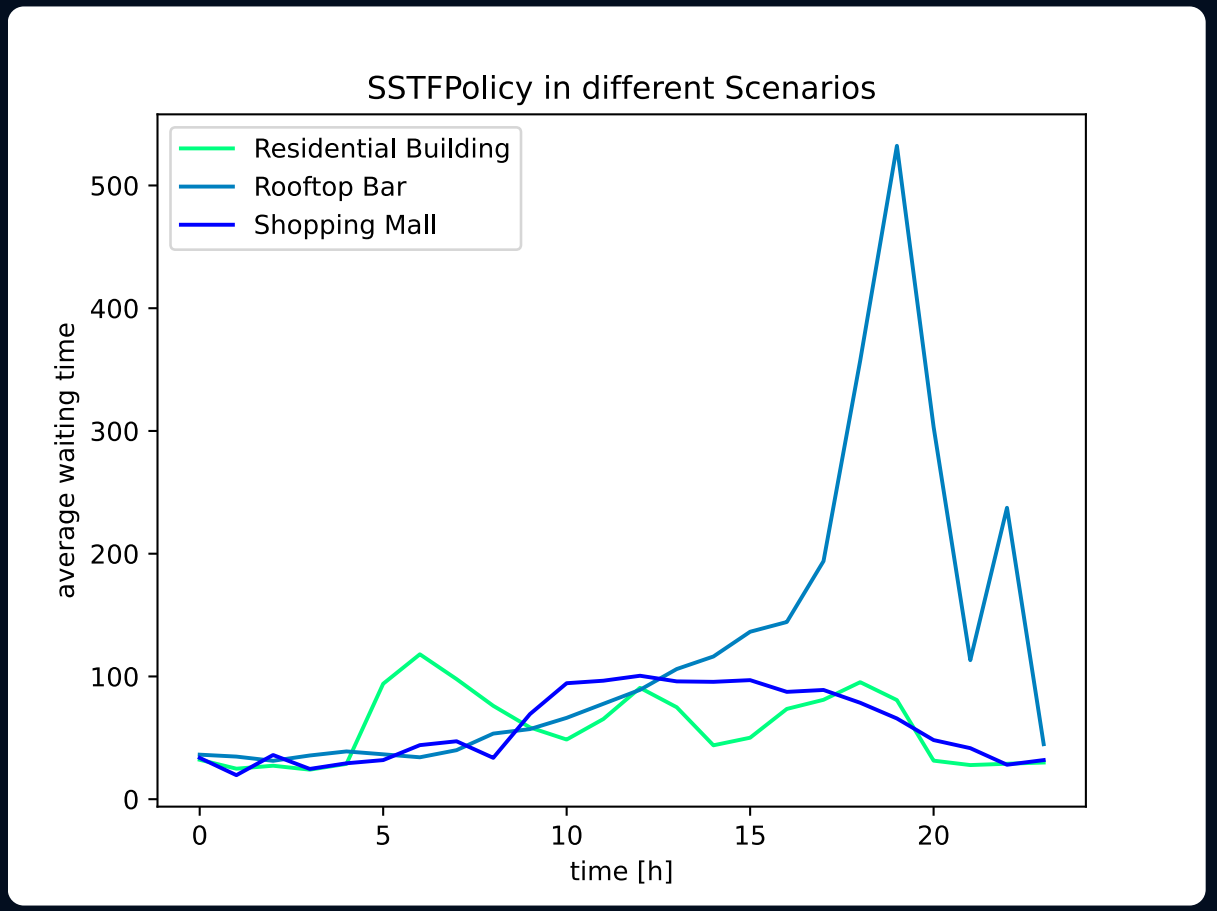

Spawnrate in different Scenarios
Residential Building
Rooftop Bar
Shopping Mall
amount of people
time [h]
0
5
10
15
20
0
50
100
150
200
250
300
350

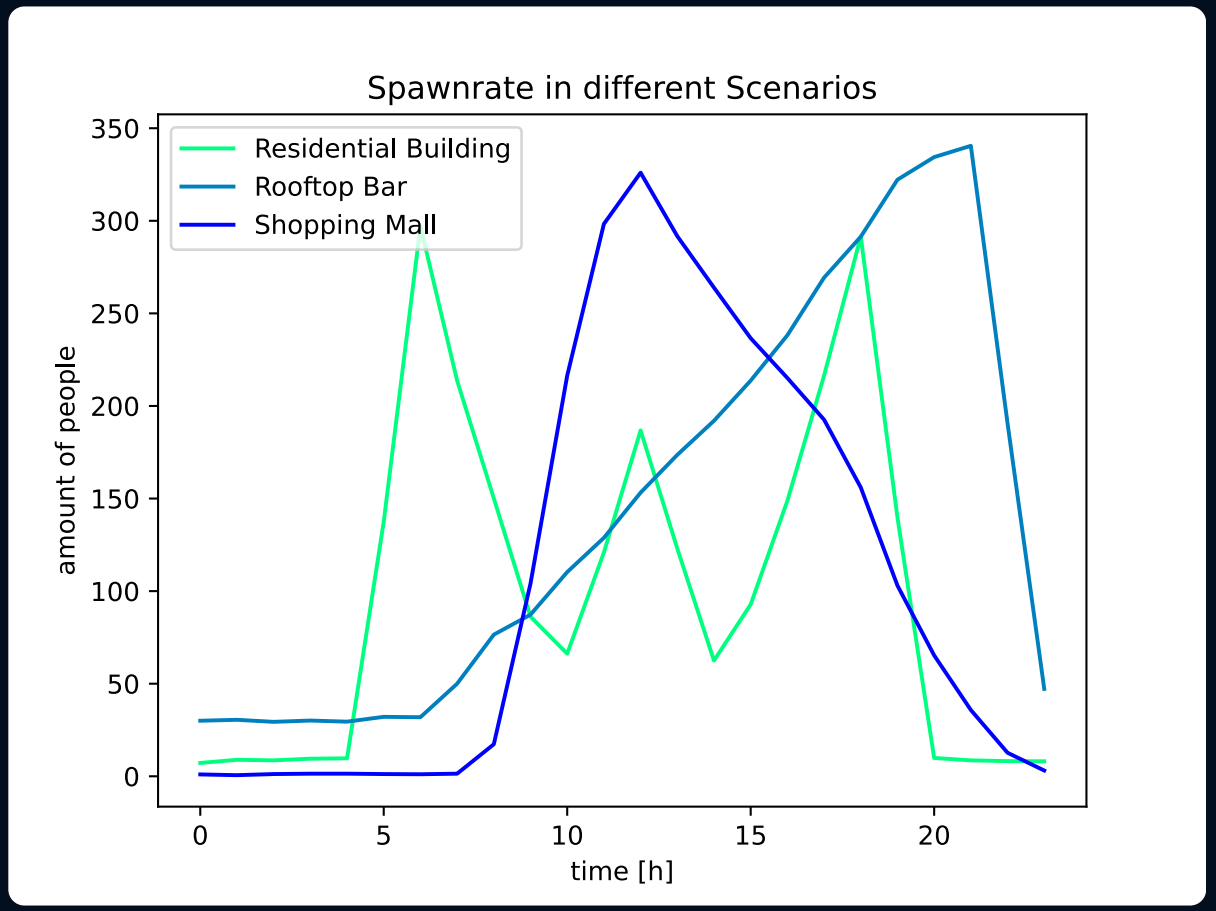
LIVE DEMO

FCFS POLICY

POLICIES


SSTF POLICY
CLOSEST FLOOR BUTTON PUSHED
CLOSEST FLOOR REQUEST
X
SECOND CLOSEST FLOOR REQUEST
X
THIRD CLOSEST FLOOR REQUEST
X
LEAST CLOSEST FLOOR REQUEST
X
ELEVATOR IS EMPTY


SSTFPolicy in different Scenarios
Residential Building
Rooftop Bar
Shopping Mall
average waiting time
0
100
200
300
400
500
0
5
10
15
20
time [h]


Spawnrate in different Scenarios
Residential Building
Rooftop Bar
Shopping Mall
amount of people
0
50
100
150
200
250
300
350
0
5
10
15
20
time [h]

SPONTANEOUS ALIGNMENT

A GENERAL PROBLEM

LIVE DEMO

SPONTANEOUS ALIGNMENT

PWDP POLICY

PARAMETRIZED POLICY

PWDP POLICY

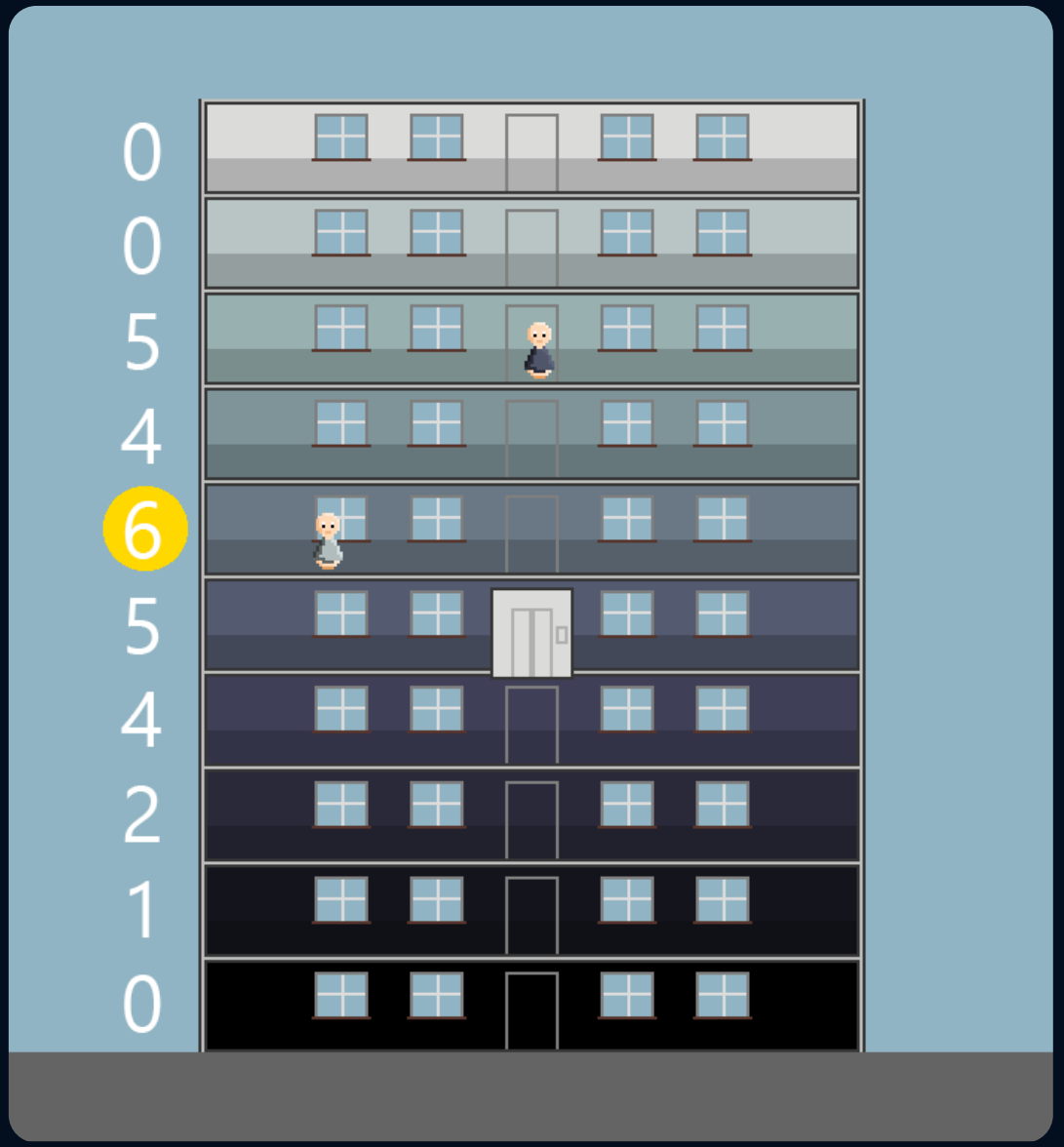
PARAMETERIZED WEIGHTED DECISION POLICY

- Our own attempt of a policy
- Tackles flaws of other policies
- Weighted decisions

PWDP POLICY

SCORE

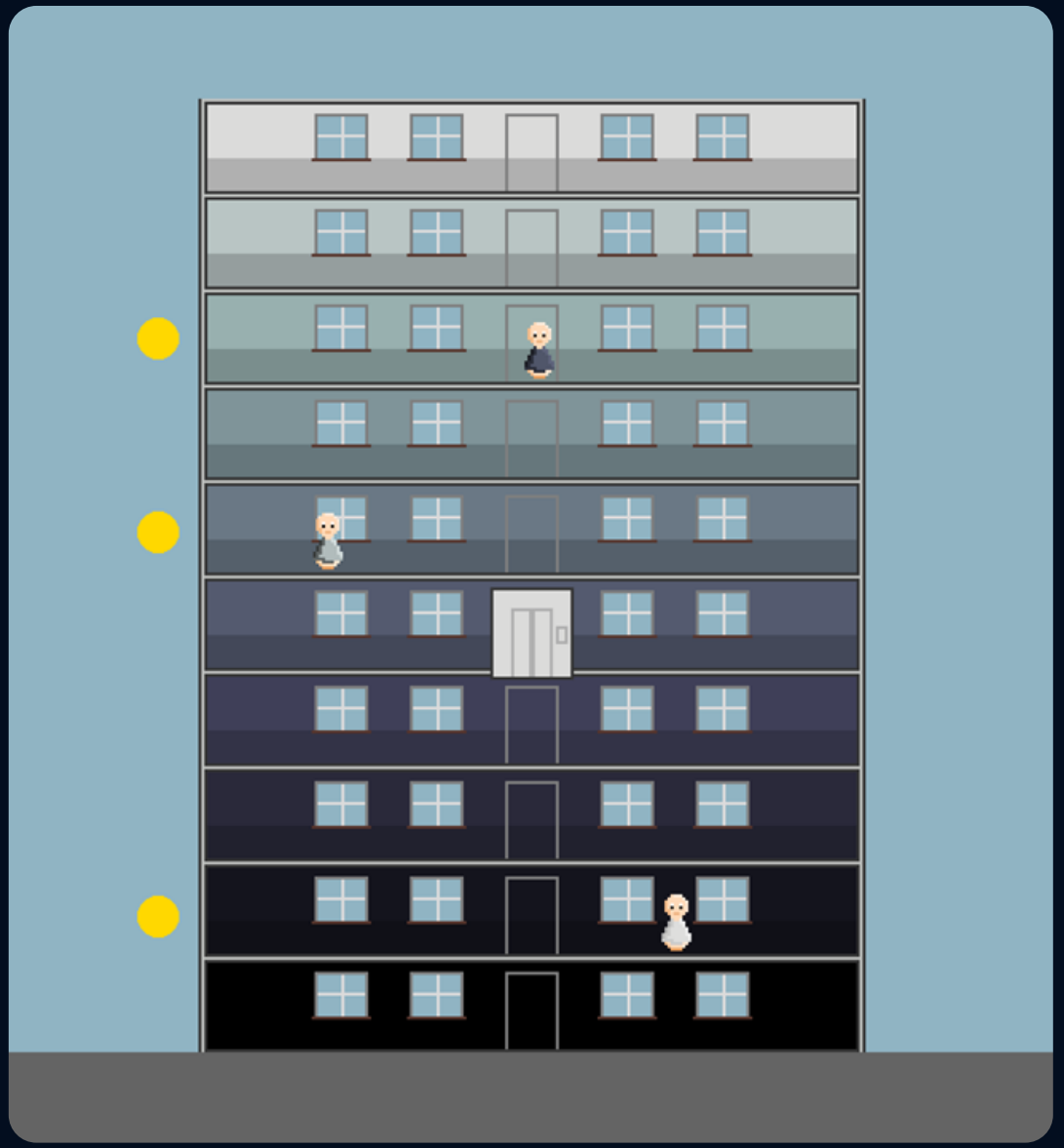
$$\mathbf{Score}[i] = \frac{s_1 + s_2 + s_3 + s_4}{\max\{1, s_5 + s_6\}}$$



PARAMETERS

FLOOR BUTTON WEIGHT

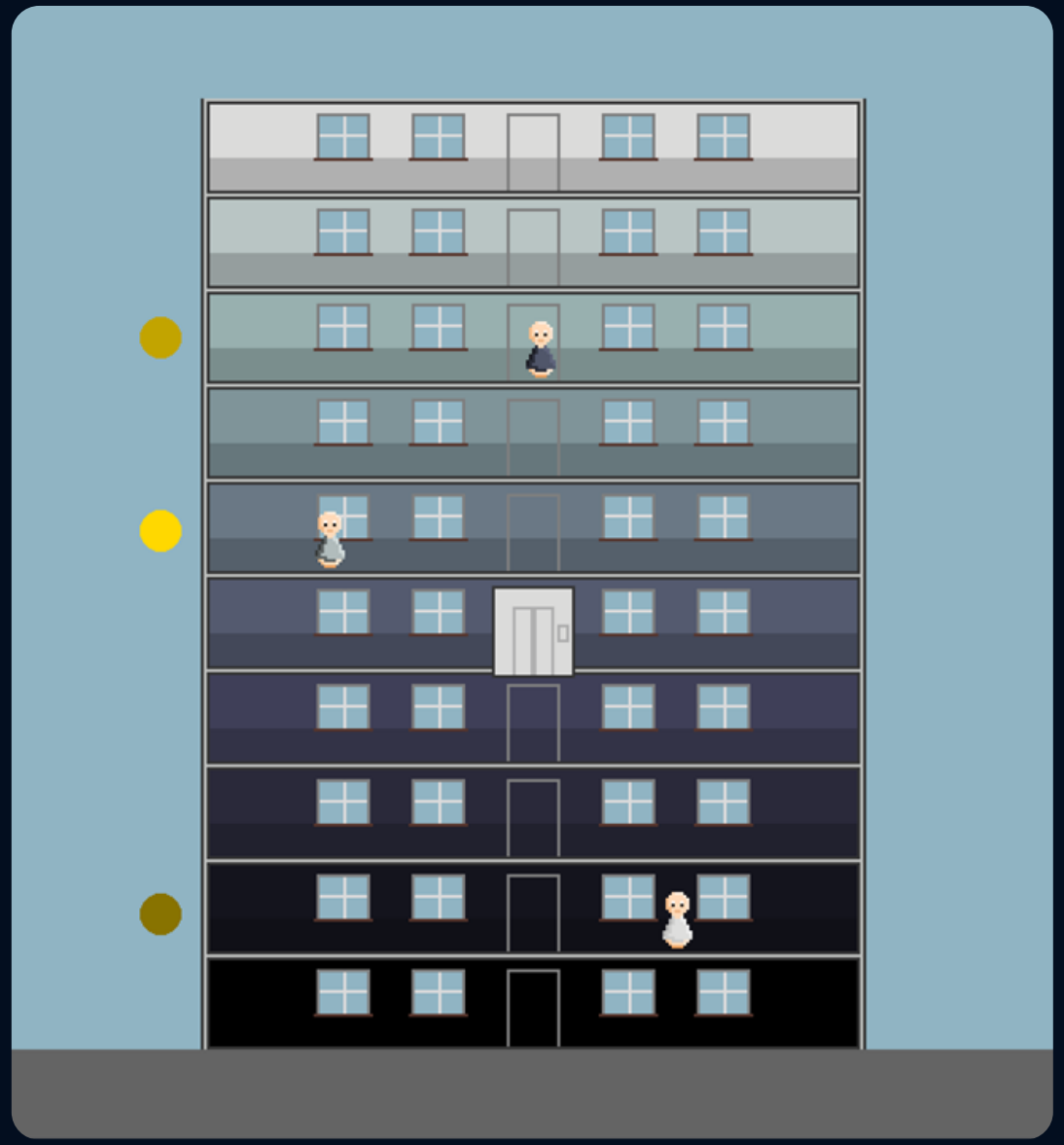
$$s_1 = \mathbf{flButtonW} \cdot \mathrm{flButtonPressed}[i]$$



PARAMETERS

FLOOR TIME WEIGHT

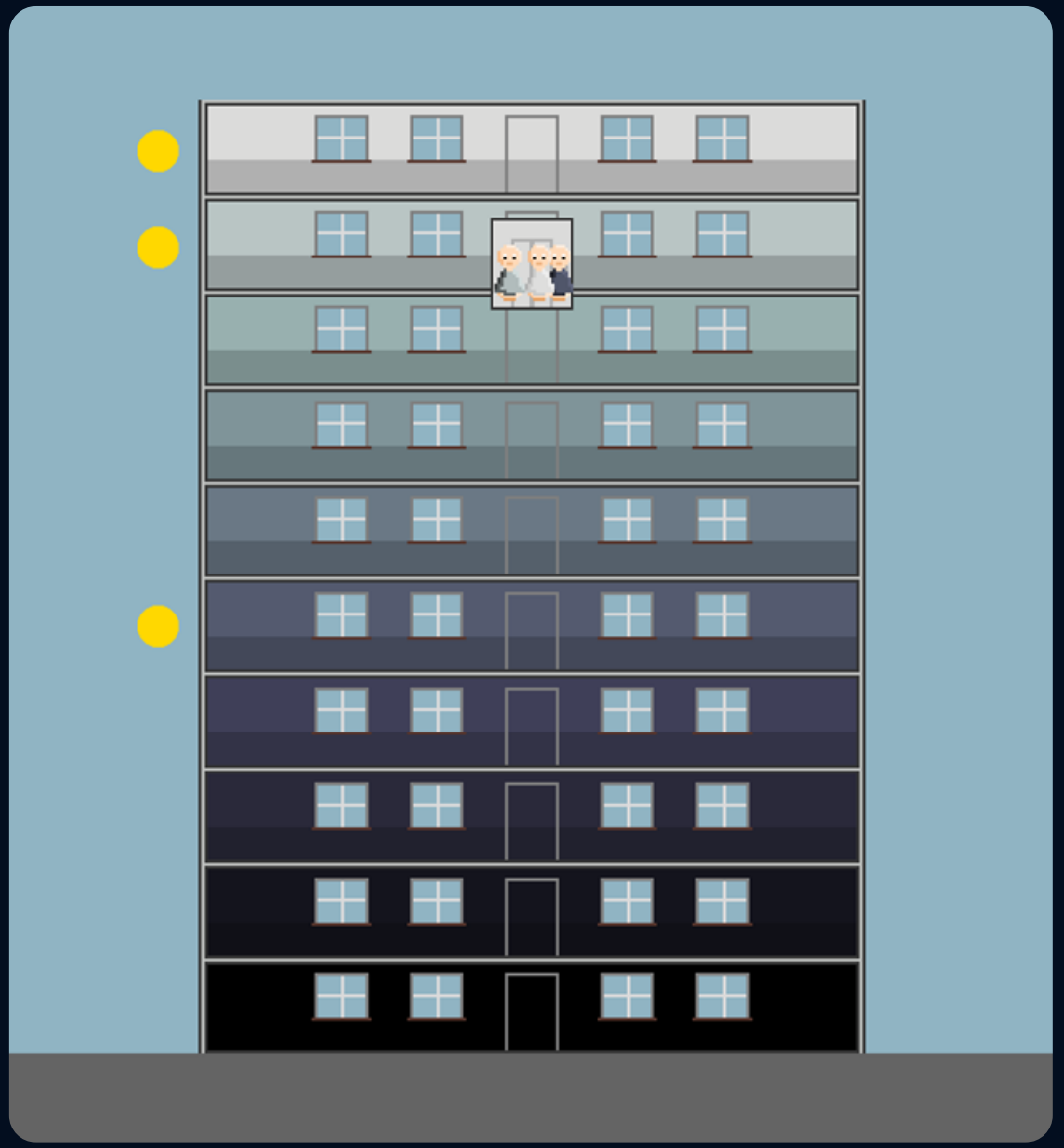
$$s_2 = \mathbf{flButtonW} \cdot \mathbf{flButtonTimeW} \cdot \text{flButtonPressed}[i] \cdot \frac{\text{flButtonTime}[i]}{\max\{1, \text{maxFlButtonTime}\}}$$



PARAMETERS

ELEVATOR BUTTON WEIGHT

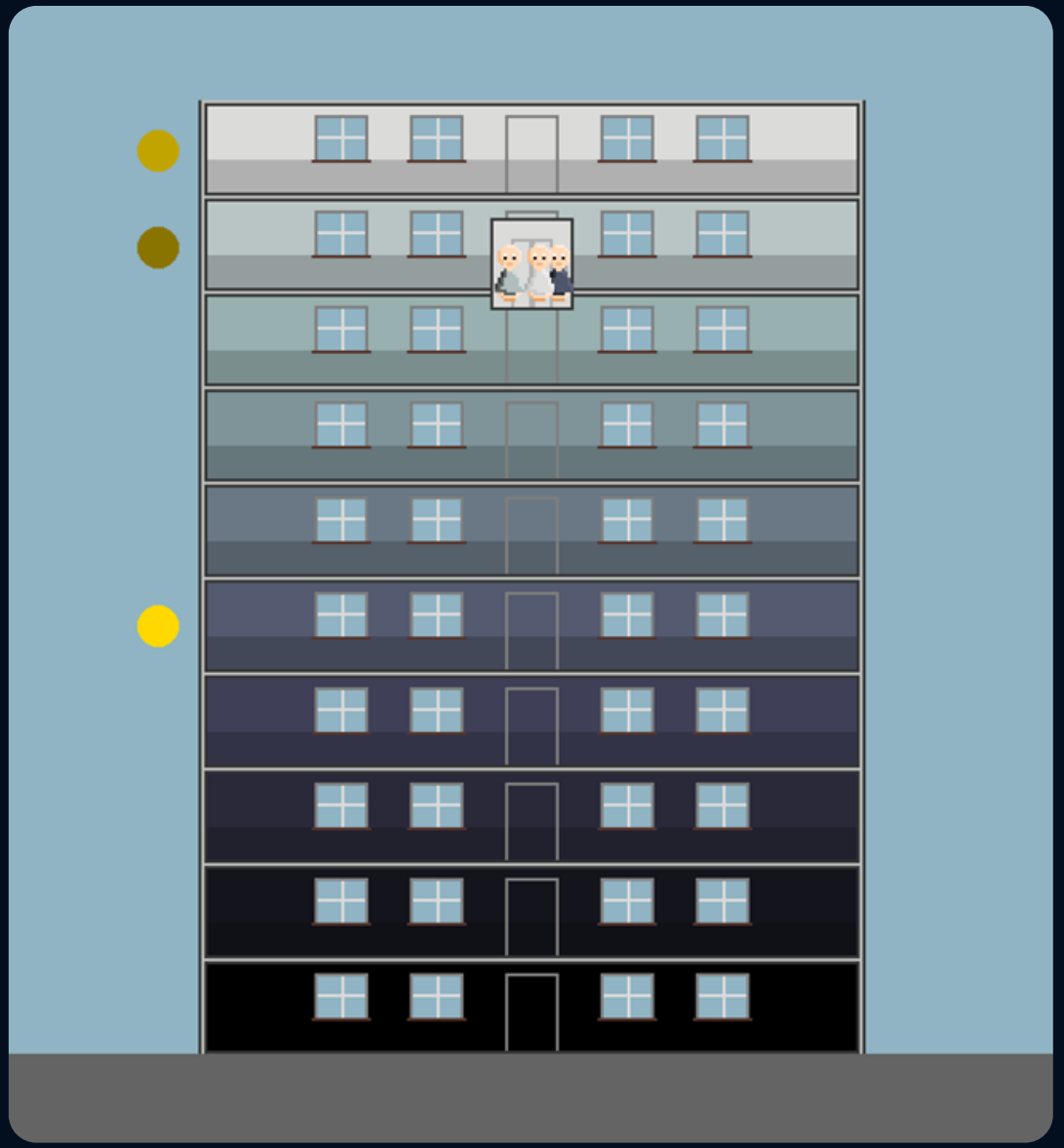
$$s_3 = \mathbf{elButtonW} \cdot \mathrm{elButtonPressed}[i]$$



PARAMETERS

ELEVATOR TIME WEIGHT

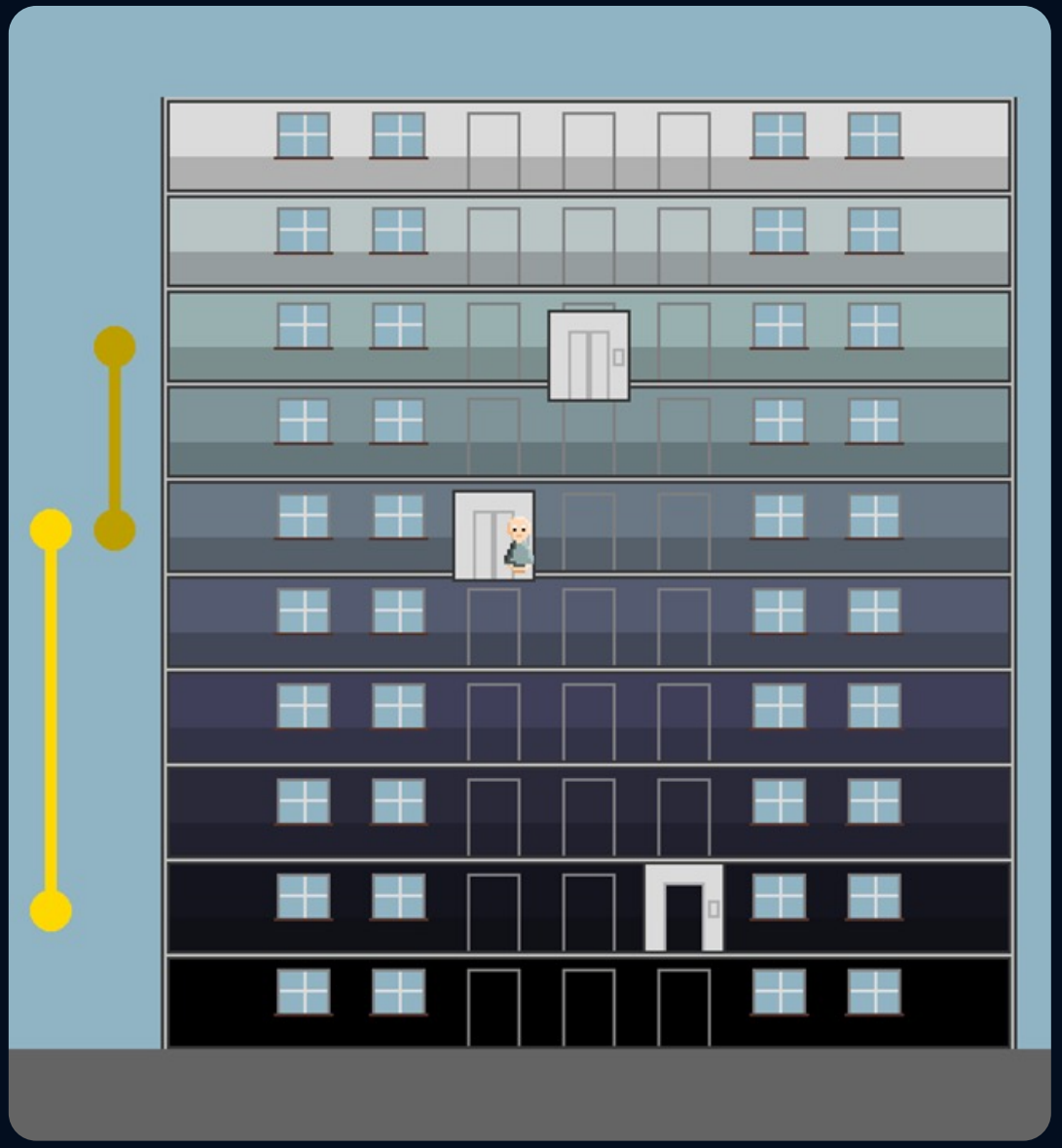
$$s_4 = \mathbf{elButtonW} \cdot \mathbf{elButtonTimeW} \cdot \text{elButtonPressed}[i] \cdot \frac{\text{elButtonTime}[i]}{\max\{1, \text{maxElButtonTime}\}}$$



PARAMETERS

COMPETITOR WEIGHT

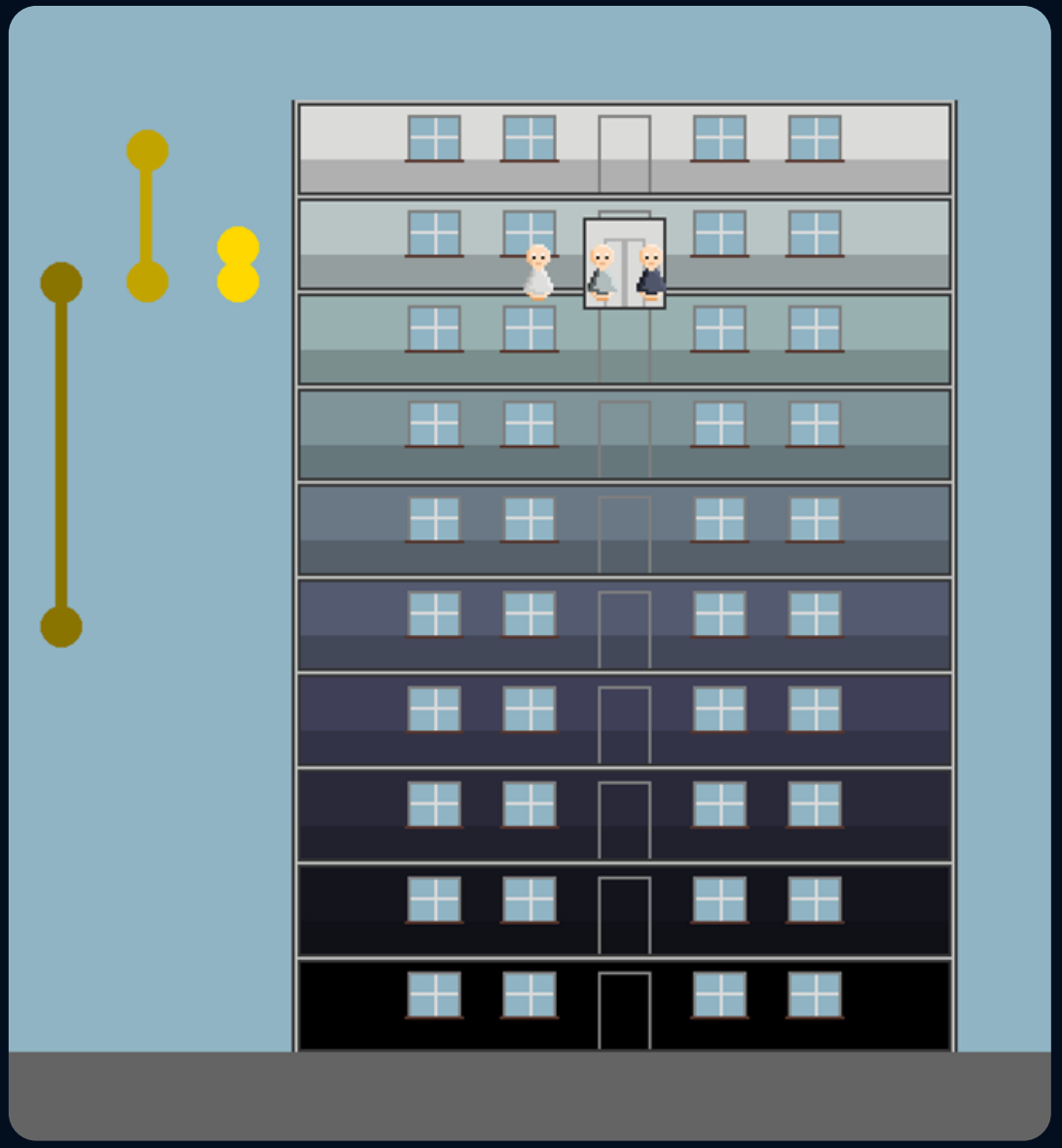
$$s_5 = \mathbf{competitorW} \cdot \sum_{j \neq \text{elIndex}} \text{distToOtherElevator}[j]$$

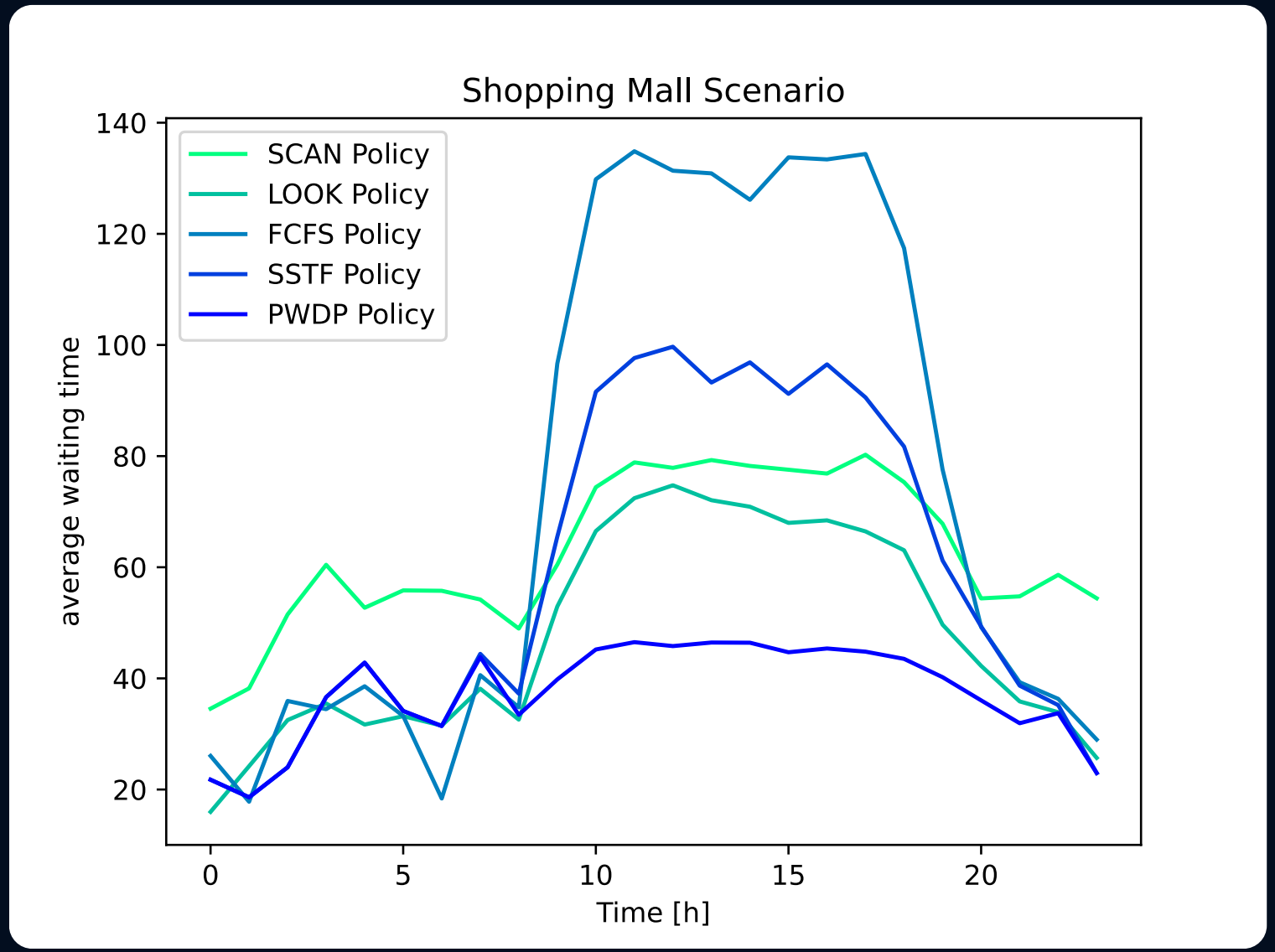


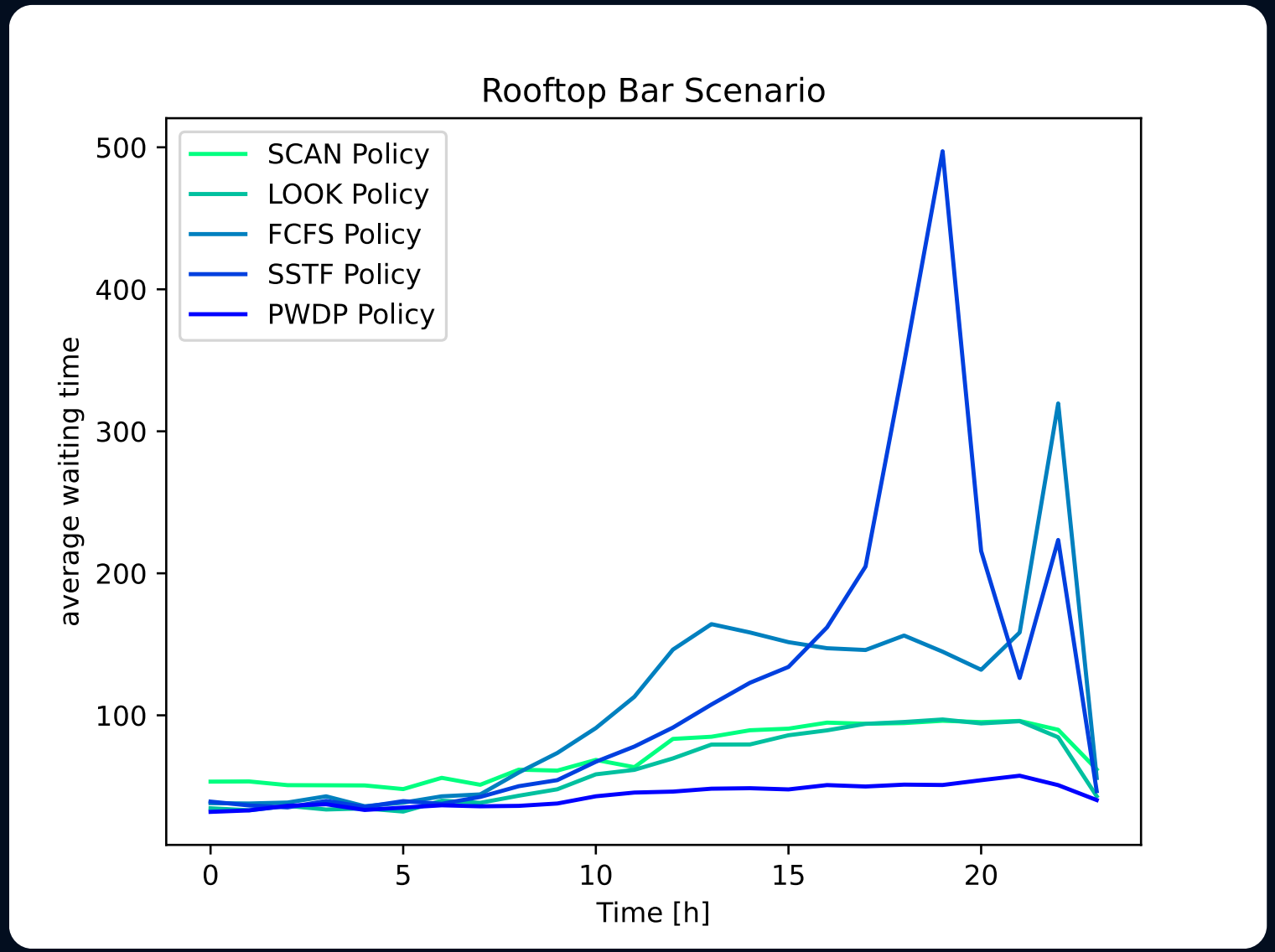
PARAMETERS

DISTANCE WEIGHT

$$s_6 = (\mathbf{distanceW})^{\mathbf{distanceExponent}\cdot |\text{currentFloor} - i|}$$

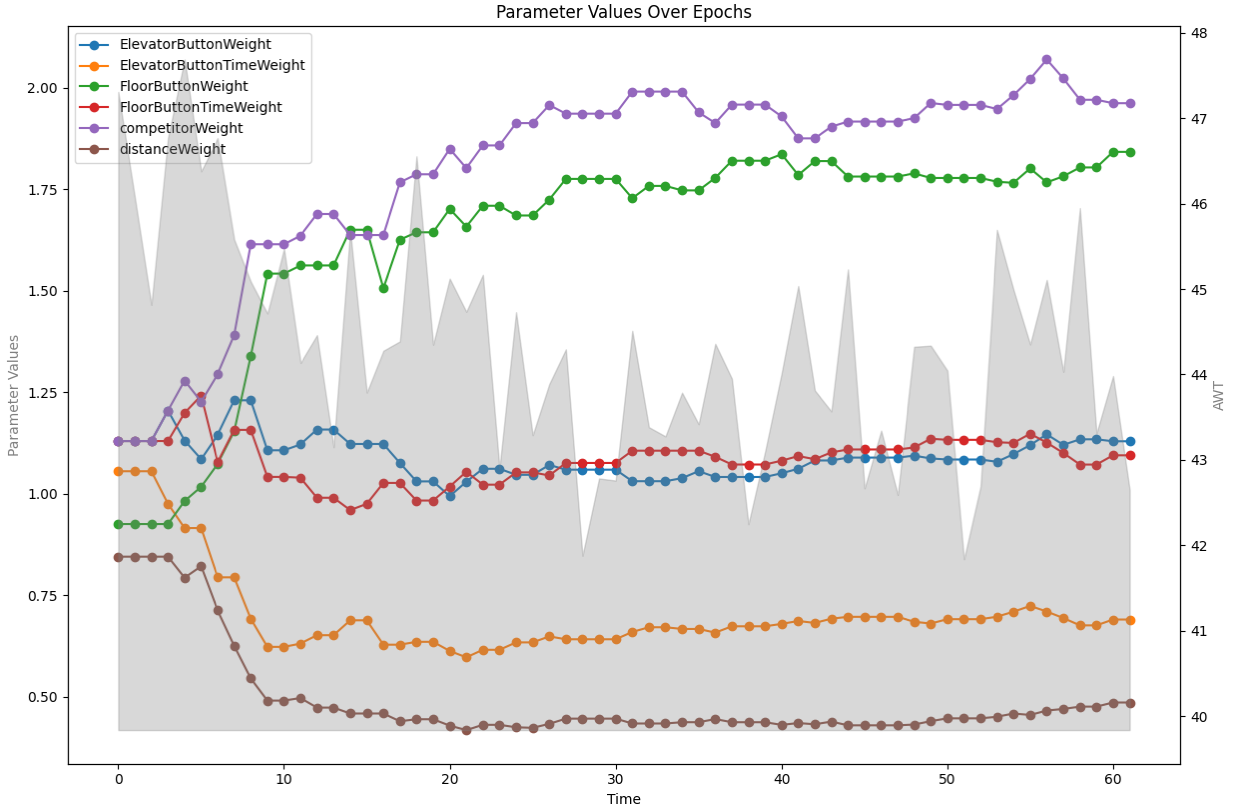



Shopping Mall Scenario
SCAN Policy
LOOK Policy
FCFS Policy
SSTF Policy
PWDP Policy
average waiting time
140
120
100
80
60
40
20
0
5
10
15
20
Time [h]


Rooftop Bar Scenario
SCAN Policy
LOOK Policy
FCFS Policy
SSTF Policy
PWDP Policy
average waiting time
500
400
300
200
100
0
5
10
15
20
Time [h]

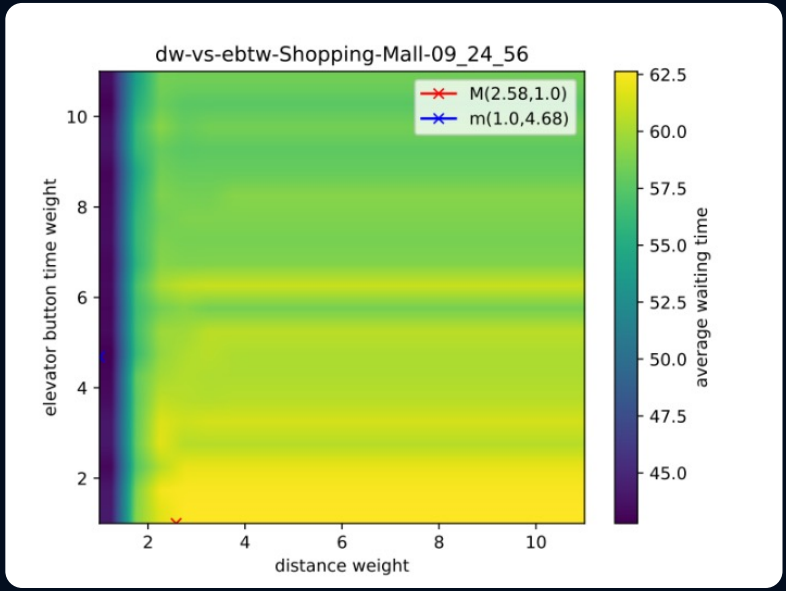
OPTIMIZATION

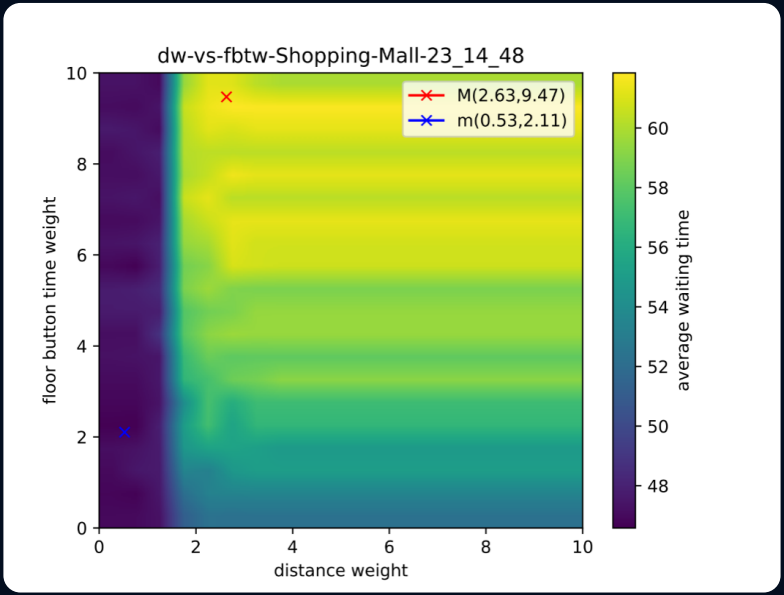
ITERATIVE PARAMETER MODIFICATION

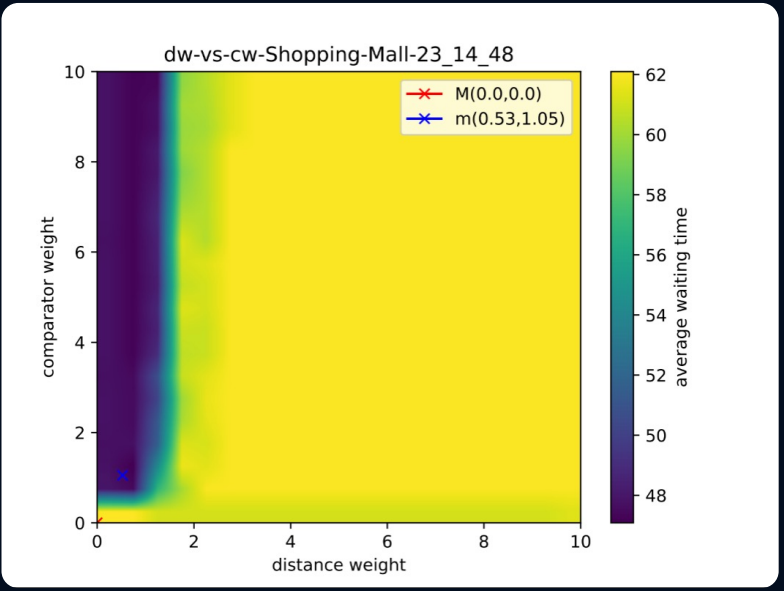


OPTIMIZATION

DISTANCE WEIGHT DECREASE





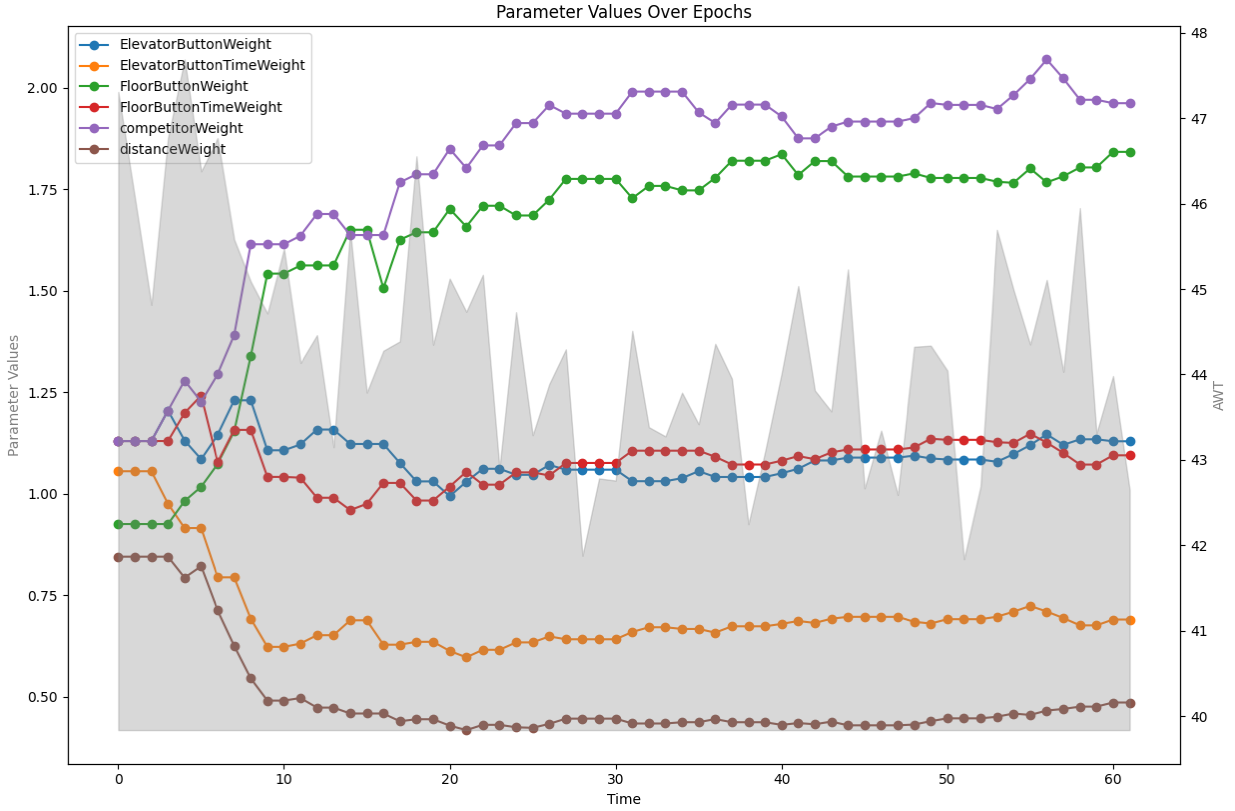


LIVE DEMO

DISTANCE WEIGHT DECREASE

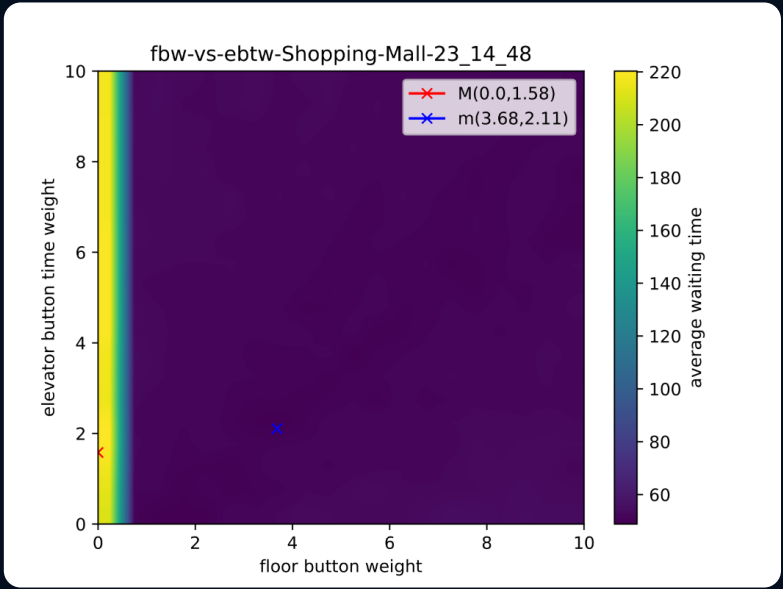
OPTIMIZATION

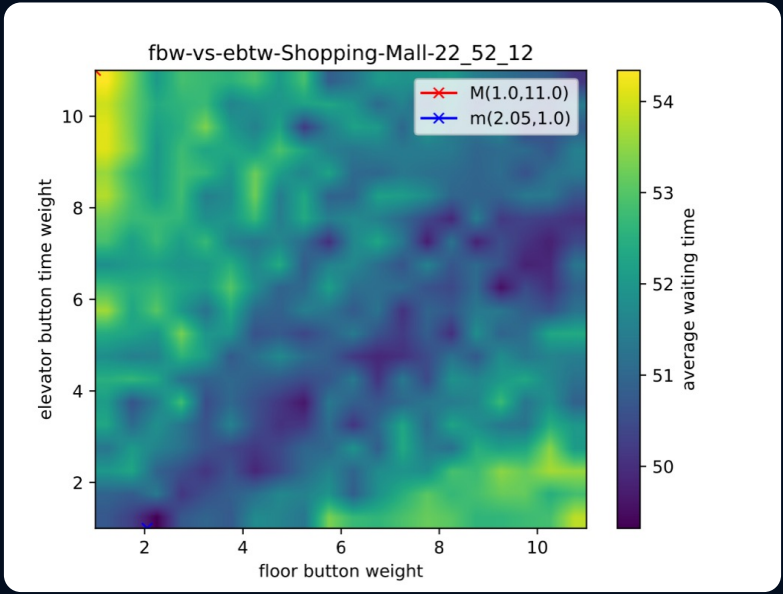
ITERATIVE PARAMETER MODIFICATION



OPTIMIZATION

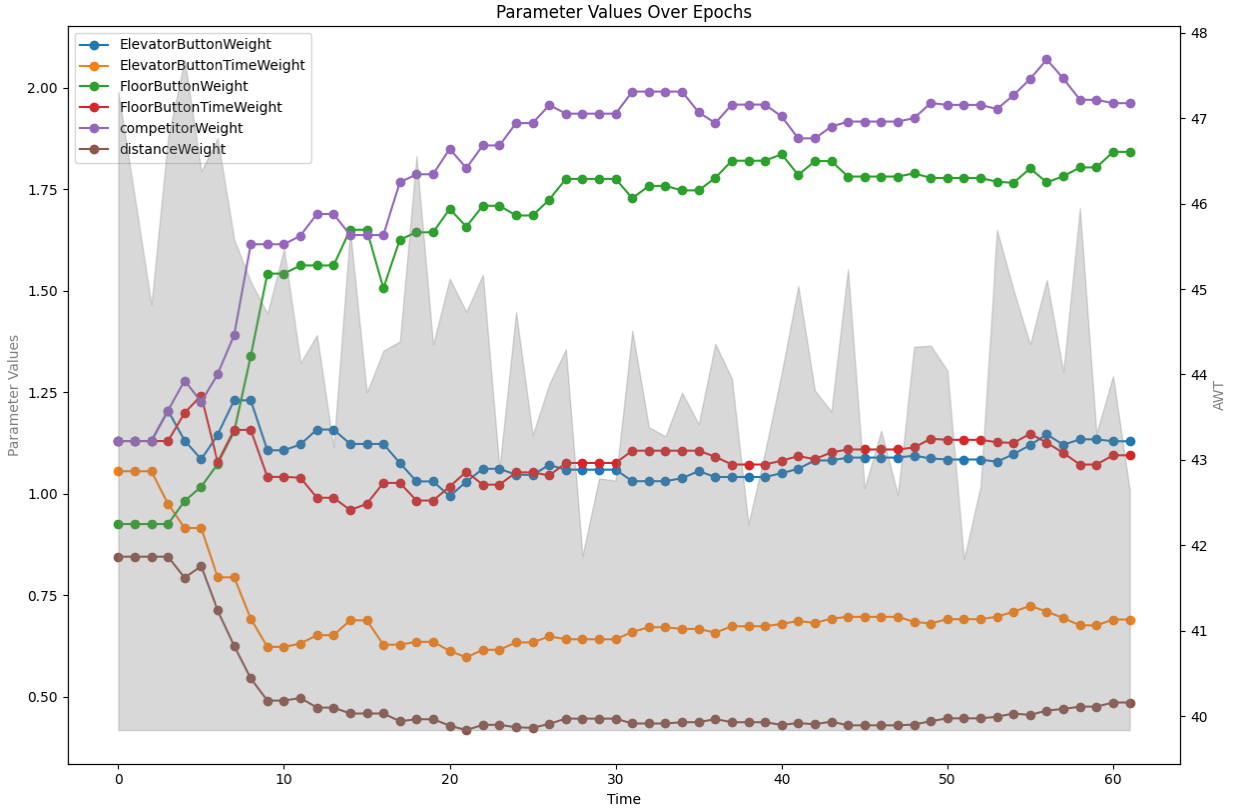
ELEVATOR TIME WEIGHT DECREASE





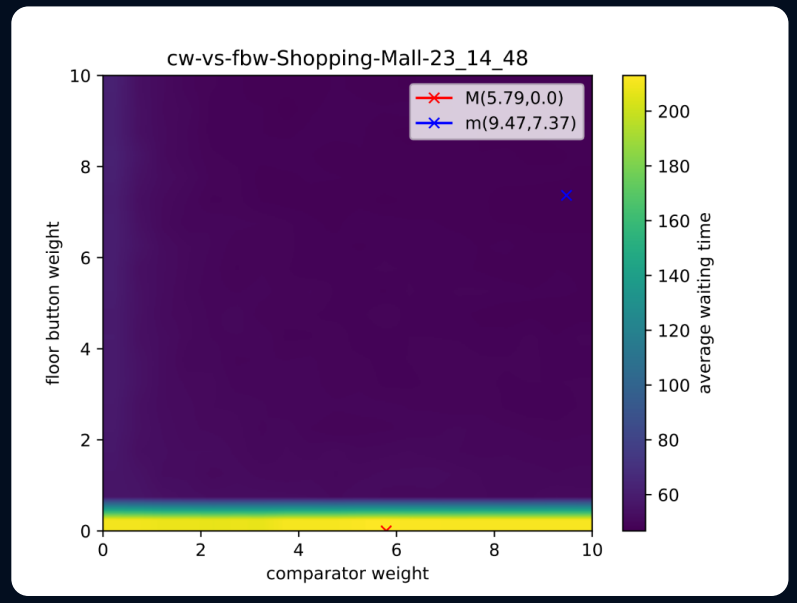
OPTIMIZATION

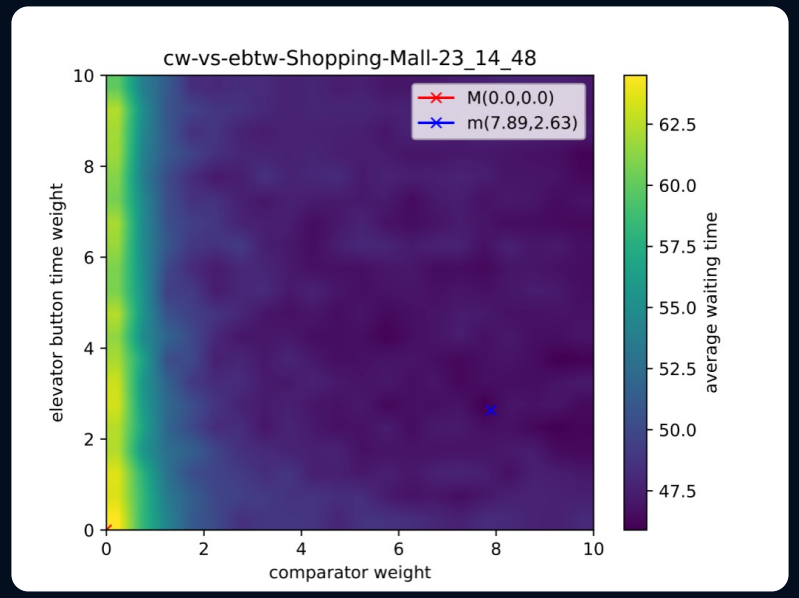
ITERATIVE PARAMETER MODIFICATION

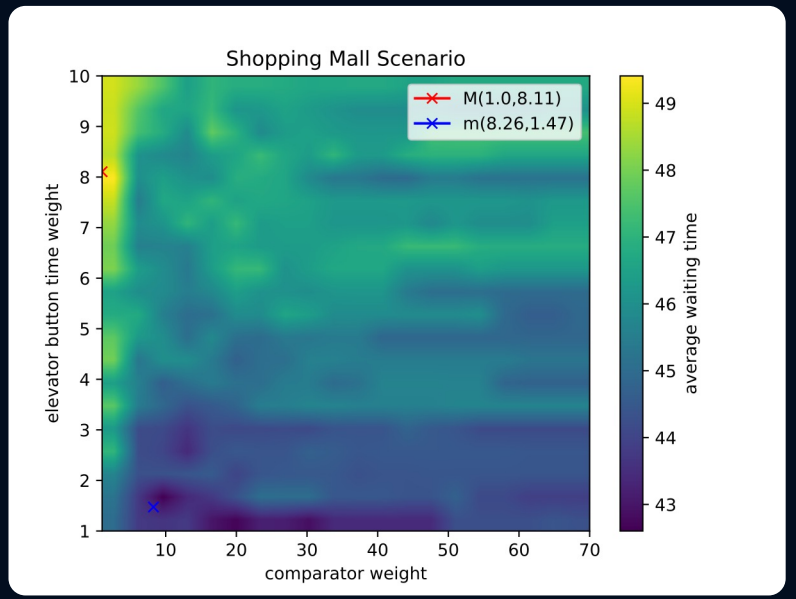


OPTIMIZATION

COMPETITOR WEIGHT INCREASE



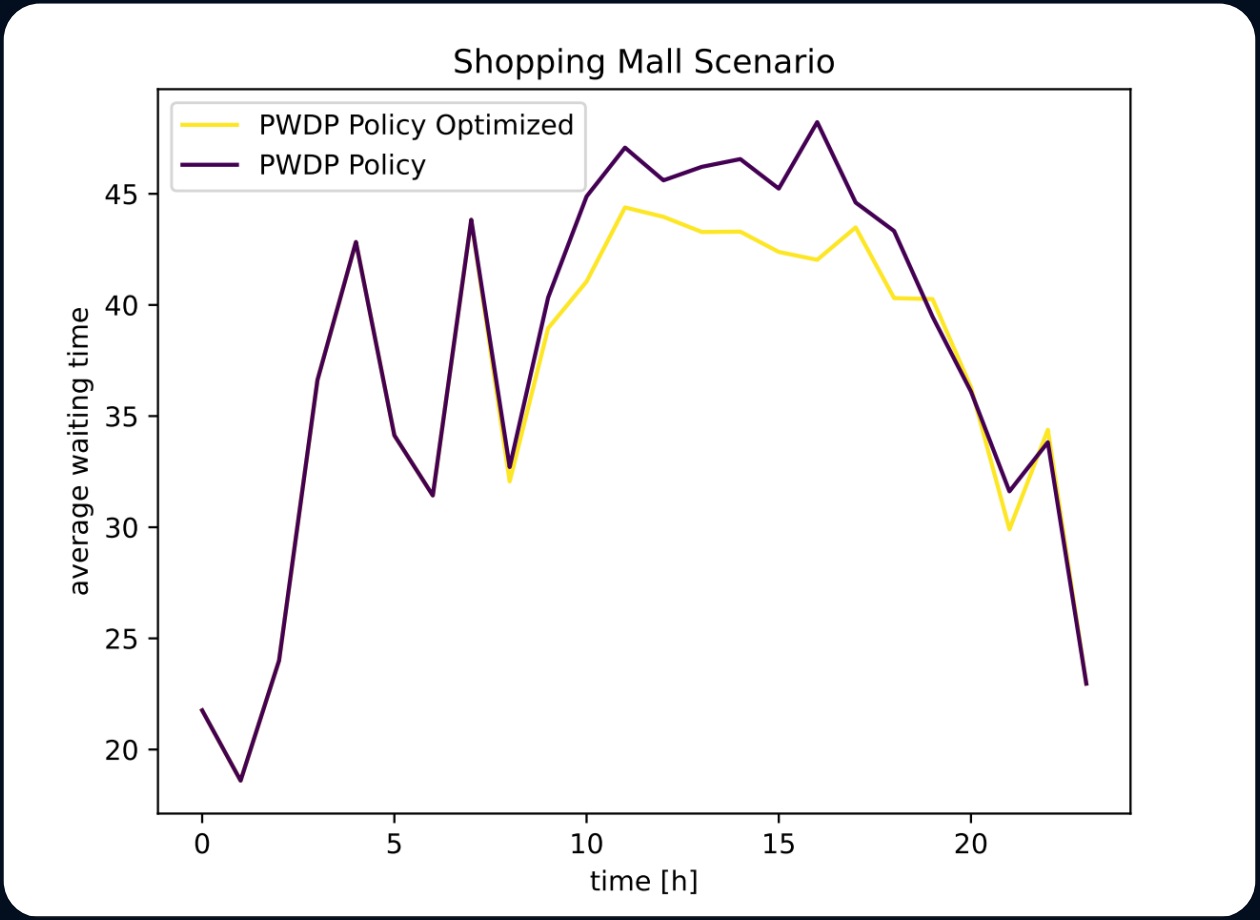




NORMALIZED OVER BUILDING HEIGHT
→ VALUES GENERALLY LOW

OPTIMIZATION

PERFORMANCE INCREASE



CONCLUSION