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In [64]: #import libraries
import simpy
import wraps
import numpy as np
import pandas as pd
import queue
import random
from functools import partial, wraps

#set display preferences
pd.set_option('display.max_rows', 20)
pd.set_option('display.max_columns', 10)

# Set up notebook to display multiple outputs in one cell
from IPython.core.interactiveshell import InteractiveShell
InteractiveShell.ast_node_interactivity = "all"
```

Coffee Shop Simulation Test

Define Staffing, Wait, Balking, Reneging

```
In [65]: #define number of baristas
baristas = 1

#define service times (in minutes)
min_service_time = 1
mean_service_time = 2
max_service_time = 5

#define reneging wait time (in minutes)
max_wait_time = 10

#define arrival pace (in minutes)
mean_inter_arrival_time = 1

#define balking tolerance (number of people in line)
balk_queue_length = 6

In [66]: #enable reproducible results
obtain_reproducible_results = True

#set simulation parameters
sim_hours = 10
fixed_sim_time = sim_hours * 60 * 60 #convert hours to seconds

#create parameter strings
parameter_strings_list = [str(sim_hours), 'hours',
                           str(baristas), str(min_service_time),
                           str(mean_service_time), str(max_service_time),
                           str(mean_inter_arrival_time), str(balk_queue_length),
                           separator = '-'
simulation_file_identifier = separator.join(parameter_strings_list)
```

Define Simulation Functions

```
In [67]: #create function for random service times
def random_service_time(min_service_time, mean_service_time, max_service_time):
    try_service_time = np.random.exponential(scale = mean_service_time)
    if (try_service_time < min_service_time):
        return(min_service_time)
    if (try_service_time > max_service_time):
        return(max_service_time)
    if (try_service_time >= min_service_time) and (try_service_time <= max_serv
        return(try_service_time)
```

```
In [68]: #create function for random arrivals and balking condition
def arrival(env, caseid, caseid_queue, event_log):
    caseid = 0
    while True:
        inter_arrival_time = round(60*np.random.exponential(scale = mean_inter
        print("Next arrival time: ", env.now + inter_arrival_time)
        yield env.timeout(inter_arrival_time)
        caseid += 1
        time = env.now
        activity = 'arrival'
        env.process(event_log_append(env, caseid, time, activity, event_log))
        yield env.timeout(0)
        if caseid_queue.qsize() < balk_queue_length:
            caseid_queue.put(caseid)
            print("Customer joins queue --> caseid =",caseid,', time = ',env.now)
            time = env.now
            activity = 'join_queue'
            env.process(event_log_append(env, caseid, time, activity, event_log))
            env.process(service_process(env, caseid_queue, event_log))
        else:
            print("Customer balks --> caseid =",caseid,', time = ',env.now,', c
            env.process(event_log_append(env, caseid, env.now, 'balk', event_lo
```

```
In [69]: #create function for flow of service and renege condition and number of baristas
def service_process(env, caseid_queue, event_log):
    with baristas_on_shift.request() as req:
        yield req
        if not caseid_queue.empty():
            queue_length_on_entering_service = caseid_queue.qsize()
            caseid = caseid_queue.get()
            wait_time = env.now - queue_length_on_entering_service * (mean_serv
            if wait_time > (max_wait_time * 60) and random.random() <= 0.3:
                print("Customer", caseid, 'left the queue after waiting for', wait_time)
                env.process(event_log_append(env, caseid, env.now, 'renege', env.now))
            else:
                #adjusts service time based on # of baristas working
                adjusted_mean_service_time = mean_service_time / baristas
                adjusted_max_service_time = max_service_time / baristas
                print("Begin_service --> caseid =", caseid, ', time = ', env.now, ',')
                env.process(event_log_append(env, caseid, env.now, 'begin_service', env.now))
                service_time = round(60 * random_service_time(min_service_time, max_service_time))
                yield env.timeout(service_time)
                queue_length_on_leaving_service = caseid_queue.qsize()
                print("End_service --> caseid =", caseid, ', time = ', env.now, ',')
                env.process(event_log_append(env, caseid, env.now, 'end_service', env.now))
```

```
In [70]: #create function to process events
def trace(env, callback):
    def get_wrapper(env_step, callback):
        @wraps(env_step)
        def tracing_step():
            if len(env._queue):
                t, prio, eid, event = env._queue[0]
                callback(t, prio, eid, event)
            return env_step()
        return tracing_step

    env.step = get_wrapper(env.step, callback)

def trace_monitor(data, t, prio, eid, event):
    data.append((t, eid, type(event)))

def test_process(env):
    yield env.timeout(1)
```

```
In [71]: #create function for creating log
def event_log_append(env, caseid, time, activity, event_log):
    event_log.append((caseid, time, activity))
    yield env.timeout(0)
```

Simulation Test

```
In [72]: #set random seed
if obtain_reproducible_results:
    np.random.seed(9876)

#set simulation trace monitoring
simulation_data = []
this_trace_monitor = partial(trace_monitor, simulation_data)
```

```

env = simpy.Environment()
trace(env, this_trace_monitor)

env.process(test_process(env))

#set FIFO queue for caseid values
caseid_queue = queue.Queue()

#set limits on baristas resource
baristas_on_shift = simpy.Resource(env, capacity = baristas)
caseid = -1

#create event log tuple
event_log = [(caseid, 0, 'null_start_simulation')]
env.process(event_log_append(env, caseid, env.now, 'start_simulation', event_log))

#call customer arrival generator to start simulation
env.process(arrival(env, caseid, caseid_queue, event_log))

env.run(until = fixed_sim_time)

```

Out[72]: <Process(test_process) object at 0x7feb89119190>

Out[72]: <Process(event_log_append) object at 0x7feb89119b50>

Out[72]: <Process(arrival) object at 0x7feb88cc3820>

Next arrival time: 11
Customer joins queue --> caseid = 1 , time = 11 , queue_length = 1
Next arrival time: 69
Begin_service --> caseid = 1 , time = 11 , queue_length = 1
Customer joins queue --> caseid = 2 , time = 69 , queue_length = 1
Next arrival time: 156
Customer joins queue --> caseid = 3 , time = 156 , queue_length = 2
Next arrival time: 199
Customer joins queue --> caseid = 4 , time = 199 , queue_length = 3
Next arrival time: 205
Customer joins queue --> caseid = 5 , time = 205 , queue_length = 4
Next arrival time: 242
Customer joins queue --> caseid = 6 , time = 242 , queue_length = 5
Next arrival time: 251
Customer joins queue --> caseid = 7 , time = 251 , queue_length = 6
Next arrival time: 429
End_service --> caseid = 1 , time = 289 , queue_length = 6
Begin_service --> caseid = 2 , time = 289 , queue_length = 6
End_service --> caseid = 2 , time = 370 , queue_length = 5
Begin_service --> caseid = 3 , time = 370 , queue_length = 5
Customer joins queue --> caseid = 8 , time = 429 , queue_length = 5
Next arrival time: 439
End_service --> caseid = 3 , time = 430 , queue_length = 5
Begin_service --> caseid = 4 , time = 430 , queue_length = 5
Customer joins queue --> caseid = 9 , time = 439 , queue_length = 5
Next arrival time: 460
Customer joins queue --> caseid = 10 , time = 460 , queue_length = 6
Next arrival time: 469
Customer balks --> caseid = 11 , time = 469 , queue_length = 6
Next arrival time: 572
End_service --> caseid = 4 , time = 490 , queue_length = 6
Begin_service --> caseid = 5 , time = 490 , queue_length = 6
Customer joins queue --> caseid = 12 , time = 572 , queue_length = 6
Next arrival time: 642
Customer balks --> caseid = 13 , time = 642 , queue_length = 6
Next arrival time: 765
End_service --> caseid = 5 , time = 644 , queue_length = 6
Begin_service --> caseid = 6 , time = 644 , queue_length = 6
Customer joins queue --> caseid = 14 , time = 765 , queue_length = 6
Next arrival time: 851
End_service --> caseid = 6 , time = 822 , queue_length = 6
Begin_service --> caseid = 7 , time = 822 , queue_length = 6
Customer joins queue --> caseid = 15 , time = 851 , queue_length = 6
Next arrival time: 888
End_service --> caseid = 7 , time = 882 , queue_length = 6
Begin_service --> caseid = 8 , time = 882 , queue_length = 6
Customer joins queue --> caseid = 16 , time = 888 , queue_length = 6
Next arrival time: 991
Customer balks --> caseid = 17 , time = 991 , queue_length = 6
Next arrival time: 1058
Customer balks --> caseid = 18 , time = 1058 , queue_length = 6
Next arrival time: 1103
Customer balks --> caseid = 19 , time = 1103 , queue_length = 6
Next arrival time: 1171
End_service --> caseid = 8 , time = 1171 , queue_length = 6
Customer balks --> caseid = 20 , time = 1171 , queue_length = 6
Next arrival time: 1220
Begin_service --> caseid = 9 , time = 1171 , queue_length = 6
Customer joins queue --> caseid = 21 , time = 1220 , queue_length = 6
Next arrival time: 1279

Customer balks --> caseid = 22 , time = 1279 , queue_length = 6
Next arrival time: 1290
Customer balks --> caseid = 23 , time = 1290 , queue_length = 6
Next arrival time: 1416
Customer balks --> caseid = 24 , time = 1416 , queue_length = 6
Next arrival time: 1540
End_service --> caseid = 9 , time = 1471 , queue_length = 6
Begin_service --> caseid = 10 , time = 1471 , queue_length = 6
End_service --> caseid = 10 , time = 1531 , queue_length = 5
Begin_service --> caseid = 12 , time = 1531 , queue_length = 5
Customer joins queue --> caseid = 25 , time = 1540 , queue_length = 5
Next arrival time: 1619
Customer joins queue --> caseid = 26 , time = 1619 , queue_length = 6
Next arrival time: 1686
End_service --> caseid = 12 , time = 1648 , queue_length = 6
Begin_service --> caseid = 14 , time = 1648 , queue_length = 6
Customer joins queue --> caseid = 27 , time = 1686 , queue_length = 6
Next arrival time: 1785
End_service --> caseid = 14 , time = 1708 , queue_length = 6
Customer 15 left the queue after waiting for 988 minutes
Begin_service --> caseid = 16 , time = 1708 , queue_length = 5
Customer joins queue --> caseid = 28 , time = 1785 , queue_length = 5
Next arrival time: 1803
Customer joins queue --> caseid = 29 , time = 1803 , queue_length = 6
Next arrival time: 2279
End_service --> caseid = 16 , time = 1874 , queue_length = 6
Begin_service --> caseid = 21 , time = 1874 , queue_length = 6
End_service --> caseid = 21 , time = 1942 , queue_length = 5
Begin_service --> caseid = 25 , time = 1942 , queue_length = 5
End_service --> caseid = 25 , time = 2020 , queue_length = 4
Begin_service --> caseid = 26 , time = 2020 , queue_length = 4
End_service --> caseid = 26 , time = 2157 , queue_length = 3
Customer 27 left the queue after waiting for 1797 minutes
Begin_service --> caseid = 28 , time = 2157 , queue_length = 2
Customer joins queue --> caseid = 30 , time = 2279 , queue_length = 2
Next arrival time: 2382
End_service --> caseid = 28 , time = 2303 , queue_length = 2
Begin_service --> caseid = 29 , time = 2303 , queue_length = 2
End_service --> caseid = 29 , time = 2363 , queue_length = 1
Begin_service --> caseid = 30 , time = 2363 , queue_length = 1
Customer joins queue --> caseid = 31 , time = 2382 , queue_length = 1
Next arrival time: 2532
End_service --> caseid = 30 , time = 2423 , queue_length = 1
Begin_service --> caseid = 31 , time = 2423 , queue_length = 1
Customer joins queue --> caseid = 32 , time = 2532 , queue_length = 1
Next arrival time: 2614
End_service --> caseid = 31 , time = 2536 , queue_length = 1
Customer 32 left the queue after waiting for 2416 minutes
Customer joins queue --> caseid = 33 , time = 2614 , queue_length = 1
Next arrival time: 2665
Customer 33 left the queue after waiting for 2494 minutes
Customer joins queue --> caseid = 34 , time = 2665 , queue_length = 1
Next arrival time: 2682
Customer 34 left the queue after waiting for 2545 minutes
Customer joins queue --> caseid = 35 , time = 2682 , queue_length = 1
Next arrival time: 2848
Begin_service --> caseid = 35 , time = 2682 , queue_length = 1
End_service --> caseid = 35 , time = 2742 , queue_length = 0
Customer joins queue --> caseid = 36 , time = 2848 , queue_length = 1
Next arrival time: 2915

Customer 36 left the queue after waiting for 2728 minutes
Customer joins queue --> caseid = 37 , time = 2915 , queue_length = 1
Next arrival time: 2919
Begin_service --> caseid = 37 , time = 2915 , queue_length = 1
Customer joins queue --> caseid = 38 , time = 2919 , queue_length = 1
Next arrival time: 3022
End_service --> caseid = 37 , time = 2991 , queue_length = 1
Begin_service --> caseid = 38 , time = 2991 , queue_length = 1
Customer joins queue --> caseid = 39 , time = 3022 , queue_length = 1
Next arrival time: 3048
Customer joins queue --> caseid = 40 , time = 3048 , queue_length = 2
Next arrival time: 3084
End_service --> caseid = 38 , time = 3051 , queue_length = 2
Begin_service --> caseid = 39 , time = 3051 , queue_length = 2
Customer joins queue --> caseid = 41 , time = 3084 , queue_length = 2
Next arrival time: 3130
Customer joins queue --> caseid = 42 , time = 3130 , queue_length = 3
Next arrival time: 3176
End_service --> caseid = 39 , time = 3133 , queue_length = 3
Customer 40 left the queue after waiting for 2773 minutes
Begin_service --> caseid = 41 , time = 3133 , queue_length = 2
Customer joins queue --> caseid = 43 , time = 3176 , queue_length = 2
Next arrival time: 3193
Customer joins queue --> caseid = 44 , time = 3193 , queue_length = 3
Next arrival time: 3427
End_service --> caseid = 41 , time = 3383 , queue_length = 3
Begin_service --> caseid = 42 , time = 3383 , queue_length = 3
Customer joins queue --> caseid = 45 , time = 3427 , queue_length = 3
Next arrival time: 3454
Customer joins queue --> caseid = 46 , time = 3454 , queue_length = 4
Next arrival time: 3475
Customer joins queue --> caseid = 47 , time = 3475 , queue_length = 5
Next arrival time: 3503
Customer joins queue --> caseid = 48 , time = 3503 , queue_length = 6
Next arrival time: 3507
Customer balks --> caseid = 49 , time = 3507 , queue_length = 6
Next arrival time: 3655
End_service --> caseid = 42 , time = 3605 , queue_length = 6
Begin_service --> caseid = 43 , time = 3605 , queue_length = 6
Customer joins queue --> caseid = 50 , time = 3655 , queue_length = 6
Next arrival time: 3698
End_service --> caseid = 43 , time = 3665 , queue_length = 6
Begin_service --> caseid = 44 , time = 3665 , queue_length = 6
Customer joins queue --> caseid = 51 , time = 3698 , queue_length = 6
Next arrival time: 3716
Customer balks --> caseid = 52 , time = 3716 , queue_length = 6
Next arrival time: 3821
End_service --> caseid = 44 , time = 3743 , queue_length = 6
Begin_service --> caseid = 45 , time = 3743 , queue_length = 6
End_service --> caseid = 45 , time = 3812 , queue_length = 5
Begin_service --> caseid = 46 , time = 3812 , queue_length = 5
Customer joins queue --> caseid = 53 , time = 3821 , queue_length = 5
Next arrival time: 3823
Customer joins queue --> caseid = 54 , time = 3823 , queue_length = 6
Next arrival time: 3885
Customer balks --> caseid = 55 , time = 3885 , queue_length = 6
Next arrival time: 3930
Customer balks --> caseid = 56 , time = 3930 , queue_length = 6
Next arrival time: 3976
Customer balks --> caseid = 57 , time = 3976 , queue_length = 6

Next arrival time: 4057
Customer balks --> caseid = 58 , time = 4057 , queue_length = 6
Next arrival time: 4096
End_service --> caseid = 46 , time = 4072 , queue_length = 6
Customer 47 left the queue after waiting for 3352 minutes
Begin_service --> caseid = 48 , time = 4072 , queue_length = 5
Customer joins queue --> caseid = 59 , time = 4096 , queue_length = 5
Next arrival time: 4217
Customer joins queue --> caseid = 60 , time = 4217 , queue_length = 6
Next arrival time: 4235
Customer balks --> caseid = 61 , time = 4235 , queue_length = 6
Next arrival time: 4300
Customer balks --> caseid = 62 , time = 4300 , queue_length = 6
Next arrival time: 4302
Customer balks --> caseid = 63 , time = 4302 , queue_length = 6
Next arrival time: 4375
End_service --> caseid = 48 , time = 4319 , queue_length = 6
Begin_service --> caseid = 50 , time = 4319 , queue_length = 6
Customer joins queue --> caseid = 64 , time = 4375 , queue_length = 6
Next arrival time: 4430
End_service --> caseid = 50 , time = 4408 , queue_length = 6
Begin_service --> caseid = 51 , time = 4408 , queue_length = 6
Customer joins queue --> caseid = 65 , time = 4430 , queue_length = 6
Next arrival time: 4453
Customer balks --> caseid = 66 , time = 4453 , queue_length = 6
Next arrival time: 4459
Customer balks --> caseid = 67 , time = 4459 , queue_length = 6
Next arrival time: 4475
Customer balks --> caseid = 68 , time = 4475 , queue_length = 6
Next arrival time: 4494
Customer balks --> caseid = 69 , time = 4494 , queue_length = 6
Next arrival time: 4703
End_service --> caseid = 51 , time = 4568 , queue_length = 6
Customer 53 left the queue after waiting for 3848 minutes
Begin_service --> caseid = 54 , time = 4568 , queue_length = 5
End_service --> caseid = 54 , time = 4628 , queue_length = 4
Customer 59 left the queue after waiting for 4148 minutes
Customer 60 left the queue after waiting for 4268 minutes
Customer 64 left the queue after waiting for 4388 minutes
Customer 65 left the queue after waiting for 4508 minutes
Customer joins queue --> caseid = 70 , time = 4703 , queue_length = 1
Next arrival time: 4772
Customer 70 left the queue after waiting for 4583 minutes
Customer joins queue --> caseid = 71 , time = 4772 , queue_length = 1
Next arrival time: 4800
Begin_service --> caseid = 71 , time = 4772 , queue_length = 1
Customer joins queue --> caseid = 72 , time = 4800 , queue_length = 1
Next arrival time: 4806
Customer joins queue --> caseid = 73 , time = 4806 , queue_length = 2
Next arrival time: 4808
Customer joins queue --> caseid = 74 , time = 4808 , queue_length = 3
Next arrival time: 4808
Customer joins queue --> caseid = 75 , time = 4808 , queue_length = 4
Next arrival time: 4829
Customer joins queue --> caseid = 76 , time = 4829 , queue_length = 5
Next arrival time: 4918
End_service --> caseid = 71 , time = 4883 , queue_length = 5
Begin_service --> caseid = 72 , time = 4883 , queue_length = 5
Customer joins queue --> caseid = 77 , time = 4918 , queue_length = 5
Next arrival time: 5033

Customer joins queue --> caseid = 78 , time = 5033 , queue_length = 6
Next arrival time: 5158
End_service --> caseid = 72 , time = 5142 , queue_length = 6
Begin_service --> caseid = 73 , time = 5142 , queue_length = 6
Customer joins queue --> caseid = 79 , time = 5158 , queue_length = 6
Next arrival time: 5270
End_service --> caseid = 73 , time = 5202 , queue_length = 6
Customer 74 left the queue after waiting for 4482 minutes
Begin_service --> caseid = 75 , time = 5202 , queue_length = 5
Customer joins queue --> caseid = 80 , time = 5270 , queue_length = 5
Next arrival time: 5300
End_service --> caseid = 75 , time = 5274 , queue_length = 5
Customer 76 left the queue after waiting for 4674 minutes
Begin_service --> caseid = 77 , time = 5274 , queue_length = 4
Customer joins queue --> caseid = 81 , time = 5300 , queue_length = 4
Next arrival time: 5325
Customer joins queue --> caseid = 82 , time = 5325 , queue_length = 5
Next arrival time: 5413
End_service --> caseid = 77 , time = 5384 , queue_length = 5
Customer 78 left the queue after waiting for 4784 minutes
Customer 79 left the queue after waiting for 4904 minutes
Begin_service --> caseid = 80 , time = 5384 , queue_length = 3
Customer joins queue --> caseid = 83 , time = 5413 , queue_length = 3
Next arrival time: 5609
End_service --> caseid = 80 , time = 5543 , queue_length = 3
Begin_service --> caseid = 81 , time = 5543 , queue_length = 3
Customer joins queue --> caseid = 84 , time = 5609 , queue_length = 3
Next arrival time: 5623
Customer joins queue --> caseid = 85 , time = 5623 , queue_length = 4
Next arrival time: 5866
End_service --> caseid = 81 , time = 5843 , queue_length = 4
Customer 82 left the queue after waiting for 5363 minutes
Begin_service --> caseid = 83 , time = 5843 , queue_length = 3
Customer joins queue --> caseid = 86 , time = 5866 , queue_length = 3
Next arrival time: 5888
Customer joins queue --> caseid = 87 , time = 5888 , queue_length = 4
Next arrival time: 5900
Customer joins queue --> caseid = 88 , time = 5900 , queue_length = 5
Next arrival time: 5907
Customer joins queue --> caseid = 89 , time = 5907 , queue_length = 6
Next arrival time: 6020
Customer balks --> caseid = 90 , time = 6020 , queue_length = 6
Next arrival time: 6057
Customer balks --> caseid = 91 , time = 6057 , queue_length = 6
Next arrival time: 6063
Customer balks --> caseid = 92 , time = 6063 , queue_length = 6
Next arrival time: 6067
Customer balks --> caseid = 93 , time = 6067 , queue_length = 6
Next arrival time: 6119
Customer balks --> caseid = 94 , time = 6119 , queue_length = 6
Next arrival time: 6230
End_service --> caseid = 83 , time = 6143 , queue_length = 6
Begin_service --> caseid = 84 , time = 6143 , queue_length = 6
End_service --> caseid = 84 , time = 6203 , queue_length = 5
Customer 85 left the queue after waiting for 5603 minutes
Begin_service --> caseid = 86 , time = 6203 , queue_length = 4
Customer joins queue --> caseid = 95 , time = 6230 , queue_length = 4
Next arrival time: 6285
Customer joins queue --> caseid = 96 , time = 6285 , queue_length = 5
Next arrival time: 6305

Customer joins queue --> caseid = 97 , time = 6305 , queue_length = 6
Next arrival time: 6440
End_service --> caseid = 86 , time = 6307 , queue_length = 6
Begin_service --> caseid = 87 , time = 6307 , queue_length = 6
End_service --> caseid = 87 , time = 6367 , queue_length = 5
Begin_service --> caseid = 88 , time = 6367 , queue_length = 5
End_service --> caseid = 88 , time = 6427 , queue_length = 4
Begin_service --> caseid = 89 , time = 6427 , queue_length = 4
Customer joins queue --> caseid = 98 , time = 6440 , queue_length = 4
Next arrival time: 6547
Customer joins queue --> caseid = 99 , time = 6547 , queue_length = 5
Next arrival time: 6644
End_service --> caseid = 89 , time = 6617 , queue_length = 5
Begin_service --> caseid = 95 , time = 6617 , queue_length = 5
Customer joins queue --> caseid = 100 , time = 6644 , queue_length = 5
Next arrival time: 6782
Customer joins queue --> caseid = 101 , time = 6782 , queue_length = 6
Next arrival time: 6801
Customer balks --> caseid = 102 , time = 6801 , queue_length = 6
Next arrival time: 6844
End_service --> caseid = 95 , time = 6833 , queue_length = 6
Customer 96 left the queue after waiting for 6113 minutes
Begin_service --> caseid = 97 , time = 6833 , queue_length = 5
Customer joins queue --> caseid = 103 , time = 6844 , queue_length = 5
Next arrival time: 7206
End_service --> caseid = 97 , time = 6893 , queue_length = 5
Begin_service --> caseid = 98 , time = 6893 , queue_length = 5
End_service --> caseid = 98 , time = 6953 , queue_length = 4
Customer 99 left the queue after waiting for 6473 minutes
Begin_service --> caseid = 100 , time = 6953 , queue_length = 3
End_service --> caseid = 100 , time = 7134 , queue_length = 2
Customer 101 left the queue after waiting for 6894 minutes
Begin_service --> caseid = 103 , time = 7134 , queue_length = 1
End_service --> caseid = 103 , time = 7194 , queue_length = 0
Customer joins queue --> caseid = 104 , time = 7206 , queue_length = 1
Next arrival time: 7209
Begin_service --> caseid = 104 , time = 7206 , queue_length = 1
Customer joins queue --> caseid = 105 , time = 7209 , queue_length = 1
Next arrival time: 7228
Customer joins queue --> caseid = 106 , time = 7228 , queue_length = 2
Next arrival time: 7291
End_service --> caseid = 104 , time = 7266 , queue_length = 2
Begin_service --> caseid = 105 , time = 7266 , queue_length = 2
Customer joins queue --> caseid = 107 , time = 7291 , queue_length = 2
Next arrival time: 7385
End_service --> caseid = 105 , time = 7326 , queue_length = 2
Begin_service --> caseid = 106 , time = 7326 , queue_length = 2
Customer joins queue --> caseid = 108 , time = 7385 , queue_length = 2
Next arrival time: 7431
End_service --> caseid = 106 , time = 7424 , queue_length = 2
Begin_service --> caseid = 107 , time = 7424 , queue_length = 2
Customer joins queue --> caseid = 109 , time = 7431 , queue_length = 2
Next arrival time: 7496
Customer joins queue --> caseid = 110 , time = 7496 , queue_length = 3
Next arrival time: 7563
End_service --> caseid = 107 , time = 7527 , queue_length = 3
Begin_service --> caseid = 108 , time = 7527 , queue_length = 3
Customer joins queue --> caseid = 111 , time = 7563 , queue_length = 3
Next arrival time: 7637
End_service --> caseid = 108 , time = 7613 , queue_length = 3

Begin_service --> caseid = 109 , time = 7613 , queue_length = 3
Customer joins queue --> caseid = 112 , time = 7637 , queue_length = 3
Next arrival time: 7652
Customer joins queue --> caseid = 113 , time = 7652 , queue_length = 4
Next arrival time: 7751
End_service --> caseid = 109 , time = 7692 , queue_length = 4
Begin_service --> caseid = 110 , time = 7692 , queue_length = 4
Customer joins queue --> caseid = 114 , time = 7751 , queue_length = 4
Next arrival time: 7770
End_service --> caseid = 110 , time = 7752 , queue_length = 4
Begin_service --> caseid = 111 , time = 7752 , queue_length = 4
Customer joins queue --> caseid = 115 , time = 7770 , queue_length = 4
Next arrival time: 7775
Customer joins queue --> caseid = 116 , time = 7775 , queue_length = 5
Next arrival time: 7895
End_service --> caseid = 111 , time = 7812 , queue_length = 5
Begin_service --> caseid = 112 , time = 7812 , queue_length = 5
End_service --> caseid = 112 , time = 7872 , queue_length = 4
Begin_service --> caseid = 113 , time = 7872 , queue_length = 4
Customer joins queue --> caseid = 117 , time = 7895 , queue_length = 4
Next arrival time: 7896
Customer joins queue --> caseid = 118 , time = 7896 , queue_length = 5
Next arrival time: 7902
Customer joins queue --> caseid = 119 , time = 7902 , queue_length = 6
Next arrival time: 7957
Customer balks --> caseid = 120 , time = 7957 , queue_length = 6
Next arrival time: 8023
End_service --> caseid = 113 , time = 7972 , queue_length = 6
Begin_service --> caseid = 114 , time = 7972 , queue_length = 6
Customer joins queue --> caseid = 121 , time = 8023 , queue_length = 6
Next arrival time: 8092
End_service --> caseid = 114 , time = 8032 , queue_length = 6
Begin_service --> caseid = 115 , time = 8032 , queue_length = 6
Customer joins queue --> caseid = 122 , time = 8092 , queue_length = 6
Next arrival time: 8144
Customer balks --> caseid = 123 , time = 8144 , queue_length = 6
Next arrival time: 8163
Customer balks --> caseid = 124 , time = 8163 , queue_length = 6
Next arrival time: 8166
Customer balks --> caseid = 125 , time = 8166 , queue_length = 6
Next arrival time: 8201
End_service --> caseid = 115 , time = 8178 , queue_length = 6
Begin_service --> caseid = 116 , time = 8178 , queue_length = 6
Customer joins queue --> caseid = 126 , time = 8201 , queue_length = 6
Next arrival time: 8235
Customer balks --> caseid = 127 , time = 8235 , queue_length = 6
Next arrival time: 8265
End_service --> caseid = 116 , time = 8238 , queue_length = 6
Begin_service --> caseid = 117 , time = 8238 , queue_length = 6
Customer joins queue --> caseid = 128 , time = 8265 , queue_length = 6
Next arrival time: 8401
End_service --> caseid = 117 , time = 8385 , queue_length = 6
Begin_service --> caseid = 118 , time = 8385 , queue_length = 6
Customer joins queue --> caseid = 129 , time = 8401 , queue_length = 6
Next arrival time: 8473
Customer balks --> caseid = 130 , time = 8473 , queue_length = 6
Next arrival time: 8478
Customer balks --> caseid = 131 , time = 8478 , queue_length = 6
Next arrival time: 8584
End_service --> caseid = 118 , time = 8514 , queue_length = 6

Customer 119 left the queue after waiting for 7794 minutes
Begin_service --> caseid = 121 , time = 8514 , queue_length = 5
Customer joins queue --> caseid = 132 , time = 8584 , queue_length = 5
Next arrival time: 8741
Customer joins queue --> caseid = 133 , time = 8741 , queue_length = 6
Next arrival time: 8808
End_service --> caseid = 121 , time = 8806 , queue_length = 6
Begin_service --> caseid = 122 , time = 8806 , queue_length = 6
Customer joins queue --> caseid = 134 , time = 8808 , queue_length = 6
Next arrival time: 8991
End_service --> caseid = 122 , time = 8899 , queue_length = 6
Begin_service --> caseid = 126 , time = 8899 , queue_length = 6
Customer joins queue --> caseid = 135 , time = 8991 , queue_length = 6
Next arrival time: 9040
End_service --> caseid = 126 , time = 9031 , queue_length = 6
Customer 128 left the queue after waiting for 8311 minutes
Customer 129 left the queue after waiting for 8431 minutes
Begin_service --> caseid = 132 , time = 9031 , queue_length = 4
Customer joins queue --> caseid = 136 , time = 9040 , queue_length = 4
Next arrival time: 9063
Customer joins queue --> caseid = 137 , time = 9063 , queue_length = 5
Next arrival time: 9236
End_service --> caseid = 132 , time = 9091 , queue_length = 5
Customer 133 left the queue after waiting for 8491 minutes
Begin_service --> caseid = 134 , time = 9091 , queue_length = 4
End_service --> caseid = 134 , time = 9151 , queue_length = 3
Customer 135 left the queue after waiting for 8791 minutes
Begin_service --> caseid = 136 , time = 9151 , queue_length = 2
Customer joins queue --> caseid = 138 , time = 9236 , queue_length = 2
Next arrival time: 9425
End_service --> caseid = 136 , time = 9341 , queue_length = 2
Begin_service --> caseid = 137 , time = 9341 , queue_length = 2
Customer joins queue --> caseid = 139 , time = 9425 , queue_length = 2
Next arrival time: 9509
Customer joins queue --> caseid = 140 , time = 9509 , queue_length = 3
Next arrival time: 9575
End_service --> caseid = 137 , time = 9554 , queue_length = 3
Customer 138 left the queue after waiting for 9194 minutes
Begin_service --> caseid = 139 , time = 9554 , queue_length = 2
Customer joins queue --> caseid = 141 , time = 9575 , queue_length = 2
Next arrival time: 9610
Customer joins queue --> caseid = 142 , time = 9610 , queue_length = 3
Next arrival time: 9641
Customer joins queue --> caseid = 143 , time = 9641 , queue_length = 4
Next arrival time: 9790
End_service --> caseid = 139 , time = 9684 , queue_length = 4
Customer 140 left the queue after waiting for 9204 minutes
Customer 141 left the queue after waiting for 9324 minutes
Begin_service --> caseid = 142 , time = 9684 , queue_length = 2
Customer joins queue --> caseid = 144 , time = 9790 , queue_length = 2
Next arrival time: 10003
End_service --> caseid = 142 , time = 9857 , queue_length = 2
Begin_service --> caseid = 143 , time = 9857 , queue_length = 2
End_service --> caseid = 143 , time = 9917 , queue_length = 1
Begin_service --> caseid = 144 , time = 9917 , queue_length = 1
End_service --> caseid = 144 , time = 9987 , queue_length = 0
Customer joins queue --> caseid = 145 , time = 10003 , queue_length = 1
Next arrival time: 10200
Begin_service --> caseid = 145 , time = 10003 , queue_length = 1
End_service --> caseid = 145 , time = 10063 , queue_length = 0

Customer joins queue --> caseid = 146 , time = 10200 , queue_length = 1
Next arrival time: 10363
Begin_service --> caseid = 146 , time = 10200 , queue_length = 1
End_service --> caseid = 146 , time = 10276 , queue_length = 0
Customer joins queue --> caseid = 147 , time = 10363 , queue_length = 1
Next arrival time: 10480
Begin_service --> caseid = 147 , time = 10363 , queue_length = 1
Customer joins queue --> caseid = 148 , time = 10480 , queue_length = 1
Next arrival time: 10507
Customer joins queue --> caseid = 149 , time = 10507 , queue_length = 2
Next arrival time: 10559
End_service --> caseid = 147 , time = 10511 , queue_length = 2
Begin_service --> caseid = 148 , time = 10511 , queue_length = 2
Customer joins queue --> caseid = 150 , time = 10559 , queue_length = 2
Next arrival time: 10657
End_service --> caseid = 148 , time = 10571 , queue_length = 2
Begin_service --> caseid = 149 , time = 10571 , queue_length = 2
End_service --> caseid = 149 , time = 10631 , queue_length = 1
Begin_service --> caseid = 150 , time = 10631 , queue_length = 1
Customer joins queue --> caseid = 151 , time = 10657 , queue_length = 1
Next arrival time: 10755
Customer joins queue --> caseid = 152 , time = 10755 , queue_length = 2
Next arrival time: 10822
Customer joins queue --> caseid = 153 , time = 10822 , queue_length = 3
Next arrival time: 10832
Customer joins queue --> caseid = 154 , time = 10832 , queue_length = 4
Next arrival time: 10840
Customer joins queue --> caseid = 155 , time = 10840 , queue_length = 5
Next arrival time: 10844
Customer joins queue --> caseid = 156 , time = 10844 , queue_length = 6
Next arrival time: 10870
Customer balks --> caseid = 157 , time = 10870 , queue_length = 6
Next arrival time: 10972
End_service --> caseid = 150 , time = 10895 , queue_length = 6
Begin_service --> caseid = 151 , time = 10895 , queue_length = 6
End_service --> caseid = 151 , time = 10955 , queue_length = 5
Begin_service --> caseid = 152 , time = 10955 , queue_length = 5
Customer joins queue --> caseid = 158 , time = 10972 , queue_length = 5
Next arrival time: 11029
End_service --> caseid = 152 , time = 11015 , queue_length = 5
Customer 153 left the queue after waiting for 10415 minutes
Customer 154 left the queue after waiting for 10535 minutes
Begin_service --> caseid = 155 , time = 11015 , queue_length = 3
Customer joins queue --> caseid = 159 , time = 11029 , queue_length = 3
Next arrival time: 11149
End_service --> caseid = 155 , time = 11075 , queue_length = 3
Begin_service --> caseid = 156 , time = 11075 , queue_length = 3
End_service --> caseid = 156 , time = 11135 , queue_length = 2
Begin_service --> caseid = 158 , time = 11135 , queue_length = 2
Customer joins queue --> caseid = 160 , time = 11149 , queue_length = 2
Next arrival time: 11182
Customer joins queue --> caseid = 161 , time = 11182 , queue_length = 3
Next arrival time: 11187
Customer joins queue --> caseid = 162 , time = 11187 , queue_length = 4
Next arrival time: 11258
Customer joins queue --> caseid = 163 , time = 11258 , queue_length = 5
Next arrival time: 11366
Customer joins queue --> caseid = 164 , time = 11366 , queue_length = 6
Next arrival time: 11381
End_service --> caseid = 158 , time = 11379 , queue_length = 6

Customer 159 left the queue after waiting for 10659 minutes
Customer 160 left the queue after waiting for 10779 minutes
Customer 161 left the queue after waiting for 10899 minutes
Begin_service --> caseid = 162 , time = 11379 , queue_length = 3
Customer joins queue --> caseid = 165 , time = 11381 , queue_length = 3
Next arrival time: 11476
End_service --> caseid = 162 , time = 11446 , queue_length = 3
Begin_service --> caseid = 163 , time = 11446 , queue_length = 3
Customer joins queue --> caseid = 166 , time = 11476 , queue_length = 3
Next arrival time: 11578
End_service --> caseid = 163 , time = 11506 , queue_length = 3
Customer 164 left the queue after waiting for 11146 minutes
Begin_service --> caseid = 165 , time = 11506 , queue_length = 2
Customer joins queue --> caseid = 167 , time = 11578 , queue_length = 2
Next arrival time: 11582
Customer joins queue --> caseid = 168 , time = 11582 , queue_length = 3
Next arrival time: 11597
Customer joins queue --> caseid = 169 , time = 11597 , queue_length = 4
Next arrival time: 11662
Customer joins queue --> caseid = 170 , time = 11662 , queue_length = 5
Next arrival time: 11758
Customer joins queue --> caseid = 171 , time = 11758 , queue_length = 6
Next arrival time: 11760
Customer balks --> caseid = 172 , time = 11760 , queue_length = 6
Next arrival time: 11768
End_service --> caseid = 165 , time = 11763 , queue_length = 6
Begin_service --> caseid = 166 , time = 11763 , queue_length = 6
Customer joins queue --> caseid = 173 , time = 11768 , queue_length = 6
Next arrival time: 11984
End_service --> caseid = 166 , time = 11823 , queue_length = 6
Begin_service --> caseid = 167 , time = 11823 , queue_length = 6
End_service --> caseid = 167 , time = 11883 , queue_length = 5
Begin_service --> caseid = 168 , time = 11883 , queue_length = 5
Customer joins queue --> caseid = 174 , time = 11984 , queue_length = 5
Next arrival time: 12033
End_service --> caseid = 168 , time = 12018 , queue_length = 5
Begin_service --> caseid = 169 , time = 12018 , queue_length = 5
Customer joins queue --> caseid = 175 , time = 12033 , queue_length = 5
Next arrival time: 12035
Customer joins queue --> caseid = 176 , time = 12035 , queue_length = 6
Next arrival time: 12036
Customer balks --> caseid = 177 , time = 12036 , queue_length = 6
Next arrival time: 12042
Customer balks --> caseid = 178 , time = 12042 , queue_length = 6
Next arrival time: 12293
End_service --> caseid = 169 , time = 12168 , queue_length = 6
Begin_service --> caseid = 170 , time = 12168 , queue_length = 6
End_service --> caseid = 170 , time = 12250 , queue_length = 5
Begin_service --> caseid = 171 , time = 12250 , queue_length = 5
Customer joins queue --> caseid = 179 , time = 12293 , queue_length = 5
Next arrival time: 12332
End_service --> caseid = 171 , time = 12332 , queue_length = 5
Customer joins queue --> caseid = 180 , time = 12332 , queue_length = 6
Next arrival time: 12498
Begin_service --> caseid = 173 , time = 12332 , queue_length = 6
End_service --> caseid = 173 , time = 12392 , queue_length = 5
Begin_service --> caseid = 174 , time = 12392 , queue_length = 5
End_service --> caseid = 174 , time = 12452 , queue_length = 4
Begin_service --> caseid = 175 , time = 12452 , queue_length = 4
Customer joins queue --> caseid = 181 , time = 12498 , queue_length = 4

Next arrival time: 12578
Customer joins queue --> caseid = 182 , time = 12578 , queue_length = 5
Next arrival time: 12677
Customer joins queue --> caseid = 183 , time = 12677 , queue_length = 6
Next arrival time: 12762
End_service --> caseid = 175 , time = 12752 , queue_length = 6
Begin_service --> caseid = 176 , time = 12752 , queue_length = 6
Customer joins queue --> caseid = 184 , time = 12762 , queue_length = 6
Next arrival time: 12801
Customer balks --> caseid = 185 , time = 12801 , queue_length = 6
Next arrival time: 12868
End_service --> caseid = 176 , time = 12851 , queue_length = 6
Customer 179 left the queue after waiting for 12131 minutes
Begin_service --> caseid = 180 , time = 12851 , queue_length = 5
Customer joins queue --> caseid = 186 , time = 12868 , queue_length = 5
Next arrival time: 12948
End_service --> caseid = 180 , time = 12911 , queue_length = 5
Begin_service --> caseid = 181 , time = 12911 , queue_length = 5
Customer joins queue --> caseid = 187 , time = 12948 , queue_length = 5
Next arrival time: 13162
End_service --> caseid = 181 , time = 13057 , queue_length = 5
Begin_service --> caseid = 182 , time = 13057 , queue_length = 5
Customer joins queue --> caseid = 188 , time = 13162 , queue_length = 5
Next arrival time: 13294
End_service --> caseid = 182 , time = 13251 , queue_length = 5
Begin_service --> caseid = 183 , time = 13251 , queue_length = 5
Customer joins queue --> caseid = 189 , time = 13294 , queue_length = 5
Next arrival time: 13358
End_service --> caseid = 183 , time = 13311 , queue_length = 5
Customer 184 left the queue after waiting for 12711 minutes
Begin_service --> caseid = 186 , time = 13311 , queue_length = 4
Customer joins queue --> caseid = 190 , time = 13358 , queue_length = 4
Next arrival time: 13486
End_service --> caseid = 186 , time = 13371 , queue_length = 4
Customer 187 left the queue after waiting for 12891 minutes
Customer 188 left the queue after waiting for 13011 minutes
Customer 189 left the queue after waiting for 13131 minutes
Begin_service --> caseid = 190 , time = 13371 , queue_length = 1
End_service --> caseid = 190 , time = 13431 , queue_length = 0
Customer joins queue --> caseid = 191 , time = 13486 , queue_length = 1
Next arrival time: 13538
Begin_service --> caseid = 191 , time = 13486 , queue_length = 1
Customer joins queue --> caseid = 192 , time = 13538 , queue_length = 1
Next arrival time: 13567
End_service --> caseid = 191 , time = 13546 , queue_length = 1
Begin_service --> caseid = 192 , time = 13546 , queue_length = 1
Customer joins queue --> caseid = 193 , time = 13567 , queue_length = 1
Next arrival time: 13785
End_service --> caseid = 192 , time = 13606 , queue_length = 1
Customer 193 left the queue after waiting for 13486 minutes
Customer joins queue --> caseid = 194 , time = 13785 , queue_length = 1
Next arrival time: 13789
Customer 194 left the queue after waiting for 13665 minutes
Customer joins queue --> caseid = 195 , time = 13789 , queue_length = 1
Next arrival time: 13816
Customer 195 left the queue after waiting for 13669 minutes
Customer joins queue --> caseid = 196 , time = 13816 , queue_length = 1
Next arrival time: 13862
Customer 196 left the queue after waiting for 13696 minutes
Customer joins queue --> caseid = 197 , time = 13862 , queue_length = 1

Next arrival time: 13870
Begin_service --> caseid = 197 , time = 13862 , queue_length = 1
Customer joins queue --> caseid = 198 , time = 13870 , queue_length = 1
Next arrival time: 13909
Customer joins queue --> caseid = 199 , time = 13909 , queue_length = 2
Next arrival time: 13951
End_service --> caseid = 197 , time = 13938 , queue_length = 2
Begin_service --> caseid = 198 , time = 13938 , queue_length = 2
Customer joins queue --> caseid = 200 , time = 13951 , queue_length = 2
Next arrival time: 13968
Customer joins queue --> caseid = 201 , time = 13968 , queue_length = 3
Next arrival time: 13979
Customer joins queue --> caseid = 202 , time = 13979 , queue_length = 4
Next arrival time: 14083
Customer joins queue --> caseid = 203 , time = 14083 , queue_length = 5
Next arrival time: 14099
Customer joins queue --> caseid = 204 , time = 14099 , queue_length = 6
Next arrival time: 14252
End_service --> caseid = 198 , time = 14160 , queue_length = 6
Begin_service --> caseid = 199 , time = 14160 , queue_length = 6
Customer joins queue --> caseid = 205 , time = 14252 , queue_length = 6
Next arrival time: 14353
Customer balks --> caseid = 206 , time = 14353 , queue_length = 6
Next arrival time: 14449
End_service --> caseid = 199 , time = 14399 , queue_length = 6
Begin_service --> caseid = 200 , time = 14399 , queue_length = 6
Customer joins queue --> caseid = 207 , time = 14449 , queue_length = 6
Next arrival time: 14490
Customer balks --> caseid = 208 , time = 14490 , queue_length = 6
Next arrival time: 14500
Customer balks --> caseid = 209 , time = 14500 , queue_length = 6
Next arrival time: 14511
Customer balks --> caseid = 210 , time = 14511 , queue_length = 6
Next arrival time: 14534
Customer balks --> caseid = 211 , time = 14534 , queue_length = 6
Next arrival time: 14621
End_service --> caseid = 200 , time = 14601 , queue_length = 6
Customer 201 left the queue after waiting for 13881 minutes
Begin_service --> caseid = 202 , time = 14601 , queue_length = 5
Customer joins queue --> caseid = 212 , time = 14621 , queue_length = 5
Next arrival time: 14730
End_service --> caseid = 202 , time = 14661 , queue_length = 5
Begin_service --> caseid = 203 , time = 14661 , queue_length = 5
End_service --> caseid = 203 , time = 14721 , queue_length = 4
Begin_service --> caseid = 204 , time = 14721 , queue_length = 4
Customer joins queue --> caseid = 213 , time = 14730 , queue_length = 4
Next arrival time: 14733
Customer joins queue --> caseid = 214 , time = 14733 , queue_length = 5
Next arrival time: 14753
Customer joins queue --> caseid = 215 , time = 14753 , queue_length = 6
Next arrival time: 14839
End_service --> caseid = 204 , time = 14781 , queue_length = 6
Begin_service --> caseid = 205 , time = 14781 , queue_length = 6
Customer joins queue --> caseid = 216 , time = 14839 , queue_length = 6
Next arrival time: 14876
Customer balks --> caseid = 217 , time = 14876 , queue_length = 6
Next arrival time: 14889
Customer balks --> caseid = 218 , time = 14889 , queue_length = 6
Next arrival time: 14895
Customer balks --> caseid = 219 , time = 14895 , queue_length = 6

Next arrival time: 14909
Customer balks --> caseid = 220 , time = 14909 , queue_length = 6
Next arrival time: 14918
End_service --> caseid = 205 , time = 14917 , queue_length = 6
Begin_service --> caseid = 207 , time = 14917 , queue_length = 6
Customer joins queue --> caseid = 221 , time = 14918 , queue_length = 6
Next arrival time: 14926
Customer balks --> caseid = 222 , time = 14926 , queue_length = 6
Next arrival time: 14928
Customer balks --> caseid = 223 , time = 14928 , queue_length = 6
Next arrival time: 14996
Customer balks --> caseid = 224 , time = 14996 , queue_length = 6
Next arrival time: 15006
End_service --> caseid = 207 , time = 15004 , queue_length = 6
Begin_service --> caseid = 212 , time = 15004 , queue_length = 6
Customer joins queue --> caseid = 225 , time = 15006 , queue_length = 6
Next arrival time: 15116
Customer balks --> caseid = 226 , time = 15116 , queue_length = 6
Next arrival time: 15132
Customer balks --> caseid = 227 , time = 15132 , queue_length = 6
Next arrival time: 15287
End_service --> caseid = 212 , time = 15147 , queue_length = 6
Begin_service --> caseid = 213 , time = 15147 , queue_length = 6
Customer joins queue --> caseid = 228 , time = 15287 , queue_length = 6
Next arrival time: 15428
Customer balks --> caseid = 229 , time = 15428 , queue_length = 6
Next arrival time: 15513
End_service --> caseid = 213 , time = 15447 , queue_length = 6
Begin_service --> caseid = 214 , time = 15447 , queue_length = 6
End_service --> caseid = 214 , time = 15507 , queue_length = 5
Begin_service --> caseid = 215 , time = 15507 , queue_length = 5
Customer joins queue --> caseid = 230 , time = 15513 , queue_length = 5
Next arrival time: 15552
Customer joins queue --> caseid = 231 , time = 15552 , queue_length = 6
Next arrival time: 15603
End_service --> caseid = 215 , time = 15586 , queue_length = 6
Begin_service --> caseid = 216 , time = 15586 , queue_length = 6
Customer joins queue --> caseid = 232 , time = 15603 , queue_length = 6
Next arrival time: 15833
End_service --> caseid = 216 , time = 15693 , queue_length = 6
Begin_service --> caseid = 221 , time = 15693 , queue_length = 6
End_service --> caseid = 221 , time = 15753 , queue_length = 5
Begin_service --> caseid = 225 , time = 15753 , queue_length = 5
End_service --> caseid = 225 , time = 15813 , queue_length = 4
Begin_service --> caseid = 228 , time = 15813 , queue_length = 4
Customer joins queue --> caseid = 233 , time = 15833 , queue_length = 4
Next arrival time: 15909
Customer joins queue --> caseid = 234 , time = 15909 , queue_length = 5
Next arrival time: 16150
End_service --> caseid = 228 , time = 15959 , queue_length = 5
Begin_service --> caseid = 230 , time = 15959 , queue_length = 5
End_service --> caseid = 230 , time = 16019 , queue_length = 4
Customer 231 left the queue after waiting for 15539 minutes
Begin_service --> caseid = 232 , time = 16019 , queue_length = 3
End_service --> caseid = 232 , time = 16139 , queue_length = 2
Begin_service --> caseid = 233 , time = 16139 , queue_length = 2
Customer joins queue --> caseid = 235 , time = 16150 , queue_length = 2
Next arrival time: 16197
Customer joins queue --> caseid = 236 , time = 16197 , queue_length = 3
Next arrival time: 16406

Customer joins queue --> caseid = 237 , time = 16406 , queue_length = 4
Next arrival time: 16500
End_service --> caseid = 233 , time = 16439 , queue_length = 4
Customer 234 left the queue after waiting for 15959 minutes
Begin_service --> caseid = 235 , time = 16439 , queue_length = 3
End_service --> caseid = 235 , time = 16499 , queue_length = 2
Begin_service --> caseid = 236 , time = 16499 , queue_length = 2
Customer joins queue --> caseid = 238 , time = 16500 , queue_length = 2
Next arrival time: 16547
Customer joins queue --> caseid = 239 , time = 16547 , queue_length = 3
Next arrival time: 16597
Customer joins queue --> caseid = 240 , time = 16597 , queue_length = 4
Next arrival time: 16714
End_service --> caseid = 236 , time = 16679 , queue_length = 4
Customer 237 left the queue after waiting for 16199 minutes
Begin_service --> caseid = 238 , time = 16679 , queue_length = 3
Customer joins queue --> caseid = 241 , time = 16714 , queue_length = 3
Next arrival time: 16761
End_service --> caseid = 238 , time = 16739 , queue_length = 3
Customer 239 left the queue after waiting for 16379 minutes
Customer 240 left the queue after waiting for 16499 minutes
Customer 241 left the queue after waiting for 16619 minutes
Customer joins queue --> caseid = 242 , time = 16761 , queue_length = 1
Next arrival time: 16800
Begin_service --> caseid = 242 , time = 16761 , queue_length = 1
Customer joins queue --> caseid = 243 , time = 16800 , queue_length = 1
Next arrival time: 16977
End_service --> caseid = 242 , time = 16942 , queue_length = 1
Customer 243 left the queue after waiting for 16822 minutes
Customer joins queue --> caseid = 244 , time = 16977 , queue_length = 1
Next arrival time: 17073
Begin_service --> caseid = 244 , time = 16977 , queue_length = 1
Customer joins queue --> caseid = 245 , time = 17073 , queue_length = 1
Next arrival time: 17116
End_service --> caseid = 244 , time = 17102 , queue_length = 1
Customer 245 left the queue after waiting for 16982 minutes
Customer joins queue --> caseid = 246 , time = 17116 , queue_length = 1
Next arrival time: 17255
Begin_service --> caseid = 246 , time = 17116 , queue_length = 1
Customer joins queue --> caseid = 247 , time = 17255 , queue_length = 1
Next arrival time: 17334
End_service --> caseid = 246 , time = 17319 , queue_length = 1
Begin_service --> caseid = 247 , time = 17319 , queue_length = 1
Customer joins queue --> caseid = 248 , time = 17334 , queue_length = 1
Next arrival time: 17339
Customer joins queue --> caseid = 249 , time = 17339 , queue_length = 2
Next arrival time: 17350
Customer joins queue --> caseid = 250 , time = 17350 , queue_length = 3
Next arrival time: 17597
End_service --> caseid = 247 , time = 17379 , queue_length = 3
Begin_service --> caseid = 248 , time = 17379 , queue_length = 3
End_service --> caseid = 248 , time = 17439 , queue_length = 2
Customer 249 left the queue after waiting for 17199 minutes
Customer 250 left the queue after waiting for 17319 minutes
Customer joins queue --> caseid = 251 , time = 17597 , queue_length = 1
Next arrival time: 17625
Begin_service --> caseid = 251 , time = 17597 , queue_length = 1
Customer joins queue --> caseid = 252 , time = 17625 , queue_length = 1
Next arrival time: 17649
Customer joins queue --> caseid = 253 , time = 17649 , queue_length = 2

Next arrival time: 17683
Customer joins queue --> caseid = 254 , time = 17683 , queue_length = 3
Next arrival time: 17687
Customer joins queue --> caseid = 255 , time = 17687 , queue_length = 4
Next arrival time: 17749
Customer joins queue --> caseid = 256 , time = 17749 , queue_length = 5
Next arrival time: 17782
Customer joins queue --> caseid = 257 , time = 17782 , queue_length = 6
Next arrival time: 17803
End_service --> caseid = 251 , time = 17800 , queue_length = 6
Customer 252 left the queue after waiting for 17080 minutes
Begin_service --> caseid = 253 , time = 17800 , queue_length = 5
Customer joins queue --> caseid = 258 , time = 17803 , queue_length = 5
Next arrival time: 17858
Customer joins queue --> caseid = 259 , time = 17858 , queue_length = 6
Next arrival time: 17896
End_service --> caseid = 253 , time = 17860 , queue_length = 6
Begin_service --> caseid = 254 , time = 17860 , queue_length = 6
Customer joins queue --> caseid = 260 , time = 17896 , queue_length = 6
Next arrival time: 17965
End_service --> caseid = 254 , time = 17920 , queue_length = 6
Begin_service --> caseid = 255 , time = 17920 , queue_length = 6
Customer joins queue --> caseid = 261 , time = 17965 , queue_length = 6
Next arrival time: 17977
Customer balks --> caseid = 262 , time = 17977 , queue_length = 6
Next arrival time: 18113
End_service --> caseid = 255 , time = 17980 , queue_length = 6
Customer 256 left the queue after waiting for 17260 minutes
Customer 257 left the queue after waiting for 17380 minutes
Begin_service --> caseid = 258 , time = 17980 , queue_length = 4
End_service --> caseid = 258 , time = 18040 , queue_length = 3
Begin_service --> caseid = 259 , time = 18040 , queue_length = 3
End_service --> caseid = 259 , time = 18100 , queue_length = 2
Customer 260 left the queue after waiting for 17860 minutes
Begin_service --> caseid = 261 , time = 18100 , queue_length = 1
Customer joins queue --> caseid = 263 , time = 18113 , queue_length = 1
Next arrival time: 18136
Customer joins queue --> caseid = 264 , time = 18136 , queue_length = 2
Next arrival time: 18138
Customer joins queue --> caseid = 265 , time = 18138 , queue_length = 3
Next arrival time: 18176
End_service --> caseid = 261 , time = 18160 , queue_length = 3
Begin_service --> caseid = 263 , time = 18160 , queue_length = 3
Customer joins queue --> caseid = 266 , time = 18176 , queue_length = 3
Next arrival time: 18222
Customer joins queue --> caseid = 267 , time = 18222 , queue_length = 4
Next arrival time: 18275
End_service --> caseid = 263 , time = 18275 , queue_length = 4
Customer joins queue --> caseid = 268 , time = 18275 , queue_length = 5
Next arrival time: 18374
Begin_service --> caseid = 264 , time = 18275 , queue_length = 5
Customer joins queue --> caseid = 269 , time = 18374 , queue_length = 5
Next arrival time: 18394
End_service --> caseid = 264 , time = 18390 , queue_length = 5
Begin_service --> caseid = 265 , time = 18390 , queue_length = 5
Customer joins queue --> caseid = 270 , time = 18394 , queue_length = 5
Next arrival time: 18398
Customer joins queue --> caseid = 271 , time = 18398 , queue_length = 6
Next arrival time: 18417
Customer balks --> caseid = 272 , time = 18417 , queue_length = 6

Next arrival time: 18463
Customer balks --> caseid = 273 , time = 18463 , queue_length = 6
Next arrival time: 18486
Customer balks --> caseid = 274 , time = 18486 , queue_length = 6
Next arrival time: 18534
Customer balks --> caseid = 275 , time = 18534 , queue_length = 6
Next arrival time: 18573
Customer balks --> caseid = 276 , time = 18573 , queue_length = 6
Next arrival time: 18589
Customer balks --> caseid = 277 , time = 18589 , queue_length = 6
Next arrival time: 18618
Customer balks --> caseid = 278 , time = 18618 , queue_length = 6
Next arrival time: 18646
End_service --> caseid = 265 , time = 18625 , queue_length = 6
Begin_service --> caseid = 266 , time = 18625 , queue_length = 6
Customer joins queue --> caseid = 279 , time = 18646 , queue_length = 6
Next arrival time: 18695
Customer balks --> caseid = 280 , time = 18695 , queue_length = 6
Next arrival time: 18709
Customer balks --> caseid = 281 , time = 18709 , queue_length = 6
Next arrival time: 18753
Customer balks --> caseid = 282 , time = 18753 , queue_length = 6
Next arrival time: 18764
Customer balks --> caseid = 283 , time = 18764 , queue_length = 6
Next arrival time: 18766
Customer balks --> caseid = 284 , time = 18766 , queue_length = 6
Next arrival time: 18827
End_service --> caseid = 266 , time = 18771 , queue_length = 6
Begin_service --> caseid = 267 , time = 18771 , queue_length = 6
Customer joins queue --> caseid = 285 , time = 18827 , queue_length = 6
Next arrival time: 18836
Customer balks --> caseid = 286 , time = 18836 , queue_length = 6
Next arrival time: 18844
Customer balks --> caseid = 287 , time = 18844 , queue_length = 6
Next arrival time: 18932
Customer balks --> caseid = 288 , time = 18932 , queue_length = 6
Next arrival time: 18974
Customer balks --> caseid = 289 , time = 18974 , queue_length = 6
Next arrival time: 18979
Customer balks --> caseid = 290 , time = 18979 , queue_length = 6
Next arrival time: 18986
Customer balks --> caseid = 291 , time = 18986 , queue_length = 6
Next arrival time: 18990
Customer balks --> caseid = 292 , time = 18990 , queue_length = 6
Next arrival time: 19136
End_service --> caseid = 267 , time = 19071 , queue_length = 6
Begin_service --> caseid = 268 , time = 19071 , queue_length = 6
Customer joins queue --> caseid = 293 , time = 19136 , queue_length = 6
Next arrival time: 19138
Customer balks --> caseid = 294 , time = 19138 , queue_length = 6
Next arrival time: 19160
Customer balks --> caseid = 295 , time = 19160 , queue_length = 6
Next arrival time: 19260
Customer balks --> caseid = 296 , time = 19260 , queue_length = 6
Next arrival time: 19352
Customer balks --> caseid = 297 , time = 19352 , queue_length = 6
Next arrival time: 19503
End_service --> caseid = 268 , time = 19371 , queue_length = 6
Begin_service --> caseid = 269 , time = 19371 , queue_length = 6
End_service --> caseid = 269 , time = 19431 , queue_length = 5

Begin_service --> caseid = 270 , time = 19431 , queue_length = 5
End_service --> caseid = 270 , time = 19491 , queue_length = 4
Customer 271 left the queue after waiting for 19011 minutes
Customer 279 left the queue after waiting for 19131 minutes
Begin_service --> caseid = 285 , time = 19491 , queue_length = 2
Customer joins queue --> caseid = 298 , time = 19503 , queue_length = 2
Next arrival time: 19556
Customer joins queue --> caseid = 299 , time = 19556 , queue_length = 3
Next arrival time: 19648
End_service --> caseid = 285 , time = 19579 , queue_length = 3
Begin_service --> caseid = 293 , time = 19579 , queue_length = 3
End_service --> caseid = 293 , time = 19639 , queue_length = 2
Begin_service --> caseid = 298 , time = 19639 , queue_length = 2
Customer joins queue --> caseid = 300 , time = 19648 , queue_length = 2
Next arrival time: 19770
End_service --> caseid = 298 , time = 19699 , queue_length = 2
Begin_service --> caseid = 299 , time = 19699 , queue_length = 2
End_service --> caseid = 299 , time = 19759 , queue_length = 1
Begin_service --> caseid = 300 , time = 19759 , queue_length = 1
Customer joins queue --> caseid = 301 , time = 19770 , queue_length = 1
Next arrival time: 19843
Customer joins queue --> caseid = 302 , time = 19843 , queue_length = 2
Next arrival time: 19859
End_service --> caseid = 300 , time = 19846 , queue_length = 2
Customer 301 left the queue after waiting for 19606 minutes
Customer 302 left the queue after waiting for 19726 minutes
Customer joins queue --> caseid = 303 , time = 19859 , queue_length = 1
Next arrival time: 19908
Customer 303 left the queue after waiting for 19739 minutes
Customer joins queue --> caseid = 304 , time = 19908 , queue_length = 1
Next arrival time: 19923
Customer 304 left the queue after waiting for 19788 minutes
Customer joins queue --> caseid = 305 , time = 19923 , queue_length = 1
Next arrival time: 20049
Begin_service --> caseid = 305 , time = 19923 , queue_length = 1
End_service --> caseid = 305 , time = 19983 , queue_length = 0
Customer joins queue --> caseid = 306 , time = 20049 , queue_length = 1
Next arrival time: 20084
Customer 306 left the queue after waiting for 19929 minutes
Customer joins queue --> caseid = 307 , time = 20084 , queue_length = 1
Next arrival time: 20098
Customer 307 left the queue after waiting for 19964 minutes
Customer joins queue --> caseid = 308 , time = 20098 , queue_length = 1
Next arrival time: 20112
Begin_service --> caseid = 308 , time = 20098 , queue_length = 1
Customer joins queue --> caseid = 309 , time = 20112 , queue_length = 1
Next arrival time: 20118
Customer joins queue --> caseid = 310 , time = 20118 , queue_length = 2
Next arrival time: 20122
Customer joins queue --> caseid = 311 , time = 20122 , queue_length = 3
Next arrival time: 20217
End_service --> caseid = 308 , time = 20158 , queue_length = 3
Customer 309 left the queue after waiting for 19798 minutes
Begin_service --> caseid = 310 , time = 20158 , queue_length = 2
Customer joins queue --> caseid = 312 , time = 20217 , queue_length = 2
Next arrival time: 20218
Customer joins queue --> caseid = 313 , time = 20218 , queue_length = 3
Next arrival time: 20316
End_service --> caseid = 310 , time = 20270 , queue_length = 3
Begin_service --> caseid = 311 , time = 20270 , queue_length = 3

Customer joins queue --> caseid = 314 , time = 20316 , queue_length = 3
Next arrival time: 20361
End_service --> caseid = 311 , time = 20330 , queue_length = 3
Customer 312 left the queue after waiting for 19970 minutes
Begin_service --> caseid = 313 , time = 20330 , queue_length = 2
Customer joins queue --> caseid = 315 , time = 20361 , queue_length = 2
Next arrival time: 20386
Customer joins queue --> caseid = 316 , time = 20386 , queue_length = 3
Next arrival time: 20495
End_service --> caseid = 313 , time = 20390 , queue_length = 3
Begin_service --> caseid = 314 , time = 20390 , queue_length = 3
Customer joins queue --> caseid = 317 , time = 20495 , queue_length = 3
Next arrival time: 20513
Customer joins queue --> caseid = 318 , time = 20513 , queue_length = 4
Next arrival time: 20685
End_service --> caseid = 314 , time = 20522 , queue_length = 4
Customer 315 left the queue after waiting for 20042 minutes
Begin_service --> caseid = 316 , time = 20522 , queue_length = 3
End_service --> caseid = 316 , time = 20582 , queue_length = 2
Begin_service --> caseid = 317 , time = 20582 , queue_length = 2
Customer joins queue --> caseid = 319 , time = 20685 , queue_length = 2
Next arrival time: 20735
Customer joins queue --> caseid = 320 , time = 20735 , queue_length = 3
Next arrival time: 21011
End_service --> caseid = 317 , time = 20791 , queue_length = 3
Begin_service --> caseid = 318 , time = 20791 , queue_length = 3
End_service --> caseid = 318 , time = 20851 , queue_length = 2
Begin_service --> caseid = 319 , time = 20851 , queue_length = 2
End_service --> caseid = 319 , time = 20911 , queue_length = 1
Begin_service --> caseid = 320 , time = 20911 , queue_length = 1
End_service --> caseid = 320 , time = 20984 , queue_length = 0
Customer joins queue --> caseid = 321 , time = 21011 , queue_length = 1
Next arrival time: 21042
Customer 321 left the queue after waiting for 20891 minutes
Customer joins queue --> caseid = 322 , time = 21042 , queue_length = 1
Next arrival time: 21046
Begin_service --> caseid = 322 , time = 21042 , queue_length = 1
Customer joins queue --> caseid = 323 , time = 21046 , queue_length = 1
Next arrival time: 21165
Customer joins queue --> caseid = 324 , time = 21165 , queue_length = 2
Next arrival time: 21184
Customer joins queue --> caseid = 325 , time = 21184 , queue_length = 3
Next arrival time: 21217
Customer joins queue --> caseid = 326 , time = 21217 , queue_length = 4
Next arrival time: 21250
Customer joins queue --> caseid = 327 , time = 21250 , queue_length = 5
Next arrival time: 21274
Customer joins queue --> caseid = 328 , time = 21274 , queue_length = 6
Next arrival time: 21289
End_service --> caseid = 322 , time = 21286 , queue_length = 6
Customer 323 left the queue after waiting for 20566 minutes
Begin_service --> caseid = 324 , time = 21286 , queue_length = 5
Customer joins queue --> caseid = 329 , time = 21289 , queue_length = 5
Next arrival time: 21331
Customer joins queue --> caseid = 330 , time = 21331 , queue_length = 6
Next arrival time: 21339
Customer balks --> caseid = 331 , time = 21339 , queue_length = 6
Next arrival time: 21400
End_service --> caseid = 324 , time = 21346 , queue_length = 6
Customer 325 left the queue after waiting for 20626 minutes

Begin_service --> caseid = 326 , time = 21346 , queue_length = 5
Customer joins queue --> caseid = 332 , time = 21400 , queue_length = 5
Next arrival time: 21411
End_service --> caseid = 326 , time = 21406 , queue_length = 5
Begin_service --> caseid = 327 , time = 21406 , queue_length = 5
Customer joins queue --> caseid = 333 , time = 21411 , queue_length = 5
Next arrival time: 21442
Customer joins queue --> caseid = 334 , time = 21442 , queue_length = 6
Next arrival time: 21447
Customer balks --> caseid = 335 , time = 21447 , queue_length = 6
Next arrival time: 21525
Customer balks --> caseid = 336 , time = 21525 , queue_length = 6
Next arrival time: 21653
Customer balks --> caseid = 337 , time = 21653 , queue_length = 6
Next arrival time: 21714
End_service --> caseid = 327 , time = 21672 , queue_length = 6
Begin_service --> caseid = 328 , time = 21672 , queue_length = 6
Customer joins queue --> caseid = 338 , time = 21714 , queue_length = 6
Next arrival time: 21839
End_service --> caseid = 328 , time = 21732 , queue_length = 6
Begin_service --> caseid = 329 , time = 21732 , queue_length = 6
Customer joins queue --> caseid = 339 , time = 21839 , queue_length = 6
Next arrival time: 21873
Customer balks --> caseid = 340 , time = 21873 , queue_length = 6
Next arrival time: 21894
Customer balks --> caseid = 341 , time = 21894 , queue_length = 6
Next arrival time: 21924
Customer balks --> caseid = 342 , time = 21924 , queue_length = 6
Next arrival time: 21982
Customer balks --> caseid = 343 , time = 21982 , queue_length = 6
Next arrival time: 22102
End_service --> caseid = 329 , time = 22032 , queue_length = 6
Begin_service --> caseid = 330 , time = 22032 , queue_length = 6
End_service --> caseid = 330 , time = 22092 , queue_length = 5
Begin_service --> caseid = 332 , time = 22092 , queue_length = 5
Customer joins queue --> caseid = 344 , time = 22102 , queue_length = 5
Next arrival time: 22123
Customer joins queue --> caseid = 345 , time = 22123 , queue_length = 6
Next arrival time: 22233
End_service --> caseid = 332 , time = 22160 , queue_length = 6
Customer 333 left the queue after waiting for 21440 minutes
Customer 334 left the queue after waiting for 21560 minutes
Begin_service --> caseid = 338 , time = 22160 , queue_length = 4
Customer joins queue --> caseid = 346 , time = 22233 , queue_length = 4
Next arrival time: 22334
Customer joins queue --> caseid = 347 , time = 22334 , queue_length = 5
Next arrival time: 22361
Customer joins queue --> caseid = 348 , time = 22361 , queue_length = 6
Next arrival time: 22397
Customer balks --> caseid = 349 , time = 22397 , queue_length = 6
Next arrival time: 22496
End_service --> caseid = 338 , time = 22460 , queue_length = 6
Begin_service --> caseid = 339 , time = 22460 , queue_length = 6
Customer joins queue --> caseid = 350 , time = 22496 , queue_length = 6
Next arrival time: 22536
End_service --> caseid = 339 , time = 22520 , queue_length = 6
Customer 344 left the queue after waiting for 21800 minutes
Begin_service --> caseid = 345 , time = 22520 , queue_length = 5
Customer joins queue --> caseid = 351 , time = 22536 , queue_length = 5
Next arrival time: 22548

Customer joins queue --> caseid = 352 , time = 22548 , queue_length = 6
Next arrival time: 22556
Customer balks --> caseid = 353 , time = 22556 , queue_length = 6
Next arrival time: 22608
Customer balks --> caseid = 354 , time = 22608 , queue_length = 6
Next arrival time: 22624
End_service --> caseid = 345 , time = 22618 , queue_length = 6
Begin_service --> caseid = 346 , time = 22618 , queue_length = 6
Customer joins queue --> caseid = 355 , time = 22624 , queue_length = 6
Next arrival time: 22765
Customer balks --> caseid = 356 , time = 22765 , queue_length = 6
Next arrival time: 22825
End_service --> caseid = 346 , time = 22774 , queue_length = 6
Customer 347 left the queue after waiting for 22054 minutes
Begin_service --> caseid = 348 , time = 22774 , queue_length = 5
Customer joins queue --> caseid = 357 , time = 22825 , queue_length = 5
Next arrival time: 22925
Customer joins queue --> caseid = 358 , time = 22925 , queue_length = 6
Next arrival time: 22929
Customer balks --> caseid = 359 , time = 22929 , queue_length = 6
Next arrival time: 22937
Customer balks --> caseid = 360 , time = 22937 , queue_length = 6
Next arrival time: 22943
Customer balks --> caseid = 361 , time = 22943 , queue_length = 6
Next arrival time: 22947
Customer balks --> caseid = 362 , time = 22947 , queue_length = 6
Next arrival time: 23117
End_service --> caseid = 348 , time = 23074 , queue_length = 6
Customer 350 left the queue after waiting for 22354 minutes
Begin_service --> caseid = 351 , time = 23074 , queue_length = 5
Customer joins queue --> caseid = 363 , time = 23117 , queue_length = 5
Next arrival time: 23267
Customer joins queue --> caseid = 364 , time = 23267 , queue_length = 6
Next arrival time: 23544
End_service --> caseid = 351 , time = 23368 , queue_length = 6
Begin_service --> caseid = 352 , time = 23368 , queue_length = 6
End_service --> caseid = 352 , time = 23428 , queue_length = 5
Customer 355 left the queue after waiting for 22828 minutes
Begin_service --> caseid = 357 , time = 23428 , queue_length = 4
End_service --> caseid = 357 , time = 23527 , queue_length = 3
Customer 358 left the queue after waiting for 23167 minutes
Begin_service --> caseid = 363 , time = 23527 , queue_length = 2
Customer joins queue --> caseid = 365 , time = 23544 , queue_length = 2
Next arrival time: 23551
Customer joins queue --> caseid = 366 , time = 23551 , queue_length = 3
Next arrival time: 23645
End_service --> caseid = 363 , time = 23623 , queue_length = 3
Begin_service --> caseid = 364 , time = 23623 , queue_length = 3
Customer joins queue --> caseid = 367 , time = 23645 , queue_length = 3
Next arrival time: 23799
End_service --> caseid = 364 , time = 23730 , queue_length = 3
Begin_service --> caseid = 365 , time = 23730 , queue_length = 3
Customer joins queue --> caseid = 368 , time = 23799 , queue_length = 3
Next arrival time: 23896
Customer joins queue --> caseid = 369 , time = 23896 , queue_length = 4
Next arrival time: 23969
End_service --> caseid = 365 , time = 23952 , queue_length = 4
Begin_service --> caseid = 366 , time = 23952 , queue_length = 4
Customer joins queue --> caseid = 370 , time = 23969 , queue_length = 4
Next arrival time: 24005

Customer joins queue --> caseid = 371 , time = 24005 , queue_length = 5
Next arrival time: 24131
Customer joins queue --> caseid = 372 , time = 24131 , queue_length = 6
Next arrival time: 24164
Customer balks --> caseid = 373 , time = 24164 , queue_length = 6
Next arrival time: 24240
Customer balks --> caseid = 374 , time = 24240 , queue_length = 6
Next arrival time: 24244
Customer balks --> caseid = 375 , time = 24244 , queue_length = 6
Next arrival time: 24410
End_service --> caseid = 366 , time = 24252 , queue_length = 6
Begin_service --> caseid = 367 , time = 24252 , queue_length = 6
Customer joins queue --> caseid = 376 , time = 24410 , queue_length = 6
Next arrival time: 24414
Customer balks --> caseid = 377 , time = 24414 , queue_length = 6
Next arrival time: 24513
End_service --> caseid = 367 , time = 24428 , queue_length = 6
Begin_service --> caseid = 368 , time = 24428 , queue_length = 6
End_service --> caseid = 368 , time = 24488 , queue_length = 5
Begin_service --> caseid = 369 , time = 24488 , queue_length = 5
Customer joins queue --> caseid = 378 , time = 24513 , queue_length = 5
Next arrival time: 24599
End_service --> caseid = 369 , time = 24578 , queue_length = 5
Begin_service --> caseid = 370 , time = 24578 , queue_length = 5
Customer joins queue --> caseid = 379 , time = 24599 , queue_length = 5
Next arrival time: 24652
End_service --> caseid = 370 , time = 24638 , queue_length = 5
Begin_service --> caseid = 371 , time = 24638 , queue_length = 5
Customer joins queue --> caseid = 380 , time = 24652 , queue_length = 5
Next arrival time: 24705
Customer joins queue --> caseid = 381 , time = 24705 , queue_length = 6
Next arrival time: 24742
Customer balks --> caseid = 382 , time = 24742 , queue_length = 6
Next arrival time: 24807
Customer balks --> caseid = 383 , time = 24807 , queue_length = 6
Next arrival time: 24826
Customer balks --> caseid = 384 , time = 24826 , queue_length = 6
Next arrival time: 24973
End_service --> caseid = 371 , time = 24884 , queue_length = 6
Begin_service --> caseid = 372 , time = 24884 , queue_length = 6
Customer joins queue --> caseid = 385 , time = 24973 , queue_length = 6
Next arrival time: 25007
End_service --> caseid = 372 , time = 24988 , queue_length = 6
Begin_service --> caseid = 376 , time = 24988 , queue_length = 6
Customer joins queue --> caseid = 386 , time = 25007 , queue_length = 6
Next arrival time: 25087
End_service --> caseid = 376 , time = 25076 , queue_length = 6
Begin_service --> caseid = 378 , time = 25076 , queue_length = 6
Customer joins queue --> caseid = 387 , time = 25087 , queue_length = 6
Next arrival time: 25140
Customer balks --> caseid = 388 , time = 25140 , queue_length = 6
Next arrival time: 25178
Customer balks --> caseid = 389 , time = 25178 , queue_length = 6
Next arrival time: 25243
End_service --> caseid = 378 , time = 25227 , queue_length = 6
Begin_service --> caseid = 379 , time = 25227 , queue_length = 6
Customer joins queue --> caseid = 390 , time = 25243 , queue_length = 6
Next arrival time: 25261
Customer balks --> caseid = 391 , time = 25261 , queue_length = 6
Next arrival time: 25498

End_service --> caseid = 379 , time = 25287 , queue_length = 6
Begin_service --> caseid = 380 , time = 25287 , queue_length = 6
End_service --> caseid = 380 , time = 25417 , queue_length = 5
Begin_service --> caseid = 381 , time = 25417 , queue_length = 5
End_service --> caseid = 381 , time = 25477 , queue_length = 4
Begin_service --> caseid = 385 , time = 25477 , queue_length = 4
Customer joins queue --> caseid = 392 , time = 25498 , queue_length = 4
Next arrival time: 25520
Customer joins queue --> caseid = 393 , time = 25520 , queue_length = 5
Next arrival time: 25662
Customer joins queue --> caseid = 394 , time = 25662 , queue_length = 6
Next arrival time: 25764
Customer balks --> caseid = 395 , time = 25764 , queue_length = 6
Next arrival time: 25824
End_service --> caseid = 385 , time = 25777 , queue_length = 6
Begin_service --> caseid = 386 , time = 25777 , queue_length = 6
Customer joins queue --> caseid = 396 , time = 25824 , queue_length = 6
Next arrival time: 25856
End_service --> caseid = 386 , time = 25847 , queue_length = 6
Customer 387 left the queue after waiting for 25127 minutes
Begin_service --> caseid = 390 , time = 25847 , queue_length = 5
Customer joins queue --> caseid = 397 , time = 25856 , queue_length = 5
Next arrival time: 25866
Customer joins queue --> caseid = 398 , time = 25866 , queue_length = 6
Next arrival time: 25949
End_service --> caseid = 390 , time = 25907 , queue_length = 6
Customer 392 left the queue after waiting for 25187 minutes
Begin_service --> caseid = 393 , time = 25907 , queue_length = 5
Customer joins queue --> caseid = 399 , time = 25949 , queue_length = 5
Next arrival time: 26018
Customer joins queue --> caseid = 400 , time = 26018 , queue_length = 6
Next arrival time: 26037
Customer balks --> caseid = 401 , time = 26037 , queue_length = 6
Next arrival time: 26106
End_service --> caseid = 393 , time = 26075 , queue_length = 6
Begin_service --> caseid = 394 , time = 26075 , queue_length = 6
Customer joins queue --> caseid = 402 , time = 26106 , queue_length = 6
Next arrival time: 26184
Customer balks --> caseid = 403 , time = 26184 , queue_length = 6
Next arrival time: 26187
Customer balks --> caseid = 404 , time = 26187 , queue_length = 6
Next arrival time: 26347
Customer balks --> caseid = 405 , time = 26347 , queue_length = 6
Next arrival time: 26382
End_service --> caseid = 394 , time = 26375 , queue_length = 6
Customer 396 left the queue after waiting for 25655 minutes
Begin_service --> caseid = 397 , time = 26375 , queue_length = 5
Customer joins queue --> caseid = 406 , time = 26382 , queue_length = 5
Next arrival time: 26395
Customer joins queue --> caseid = 407 , time = 26395 , queue_length = 6
Next arrival time: 26438
Customer balks --> caseid = 408 , time = 26438 , queue_length = 6
Next arrival time: 26602
End_service --> caseid = 397 , time = 26442 , queue_length = 6
Begin_service --> caseid = 398 , time = 26442 , queue_length = 6
End_service --> caseid = 398 , time = 26515 , queue_length = 5
Customer 399 left the queue after waiting for 25915 minutes
Begin_service --> caseid = 400 , time = 26515 , queue_length = 4
End_service --> caseid = 400 , time = 26575 , queue_length = 3
Customer 402 left the queue after waiting for 26215 minutes

Begin_service --> caseid = 406 , time = 26575 , queue_length = 2
Customer joins queue --> caseid = 409 , time = 26602 , queue_length = 2
Next arrival time: 26603
Customer joins queue --> caseid = 410 , time = 26603 , queue_length = 3
Next arrival time: 26628
Customer joins queue --> caseid = 411 , time = 26628 , queue_length = 4
Next arrival time: 26639
Customer joins queue --> caseid = 412 , time = 26639 , queue_length = 5
Next arrival time: 26723
Customer joins queue --> caseid = 413 , time = 26723 , queue_length = 6
Next arrival time: 26774
End_service --> caseid = 406 , time = 26737 , queue_length = 6
Begin_service --> caseid = 407 , time = 26737 , queue_length = 6
Customer joins queue --> caseid = 414 , time = 26774 , queue_length = 6
Next arrival time: 26777
Customer balks --> caseid = 415 , time = 26777 , queue_length = 6
Next arrival time: 26832
Customer balks --> caseid = 416 , time = 26832 , queue_length = 6
Next arrival time: 26890
Customer balks --> caseid = 417 , time = 26890 , queue_length = 6
Next arrival time: 27121
End_service --> caseid = 407 , time = 26992 , queue_length = 6
Begin_service --> caseid = 409 , time = 26992 , queue_length = 6
End_service --> caseid = 409 , time = 27052 , queue_length = 5
Begin_service --> caseid = 410 , time = 27052 , queue_length = 5
Customer joins queue --> caseid = 418 , time = 27121 , queue_length = 5
Next arrival time: 27254
End_service --> caseid = 410 , time = 27182 , queue_length = 5
Begin_service --> caseid = 411 , time = 27182 , queue_length = 5
Customer joins queue --> caseid = 419 , time = 27254 , queue_length = 5
Next arrival time: 27280
Customer joins queue --> caseid = 420 , time = 27280 , queue_length = 6
Next arrival time: 27296
Customer balks --> caseid = 421 , time = 27296 , queue_length = 6
Next arrival time: 27323
End_service --> caseid = 411 , time = 27307 , queue_length = 6
Begin_service --> caseid = 412 , time = 27307 , queue_length = 6
Customer joins queue --> caseid = 422 , time = 27323 , queue_length = 6
Next arrival time: 27501
End_service --> caseid = 412 , time = 27367 , queue_length = 6
Begin_service --> caseid = 413 , time = 27367 , queue_length = 6
End_service --> caseid = 413 , time = 27427 , queue_length = 5
Begin_service --> caseid = 414 , time = 27427 , queue_length = 5
End_service --> caseid = 414 , time = 27489 , queue_length = 4
Begin_service --> caseid = 418 , time = 27489 , queue_length = 4
Customer joins queue --> caseid = 423 , time = 27501 , queue_length = 4
Next arrival time: 27549
End_service --> caseid = 418 , time = 27549 , queue_length = 4
Customer joins queue --> caseid = 424 , time = 27549 , queue_length = 5
Next arrival time: 27663
Begin_service --> caseid = 419 , time = 27549 , queue_length = 5
Customer joins queue --> caseid = 425 , time = 27663 , queue_length = 5
Next arrival time: 27793
End_service --> caseid = 419 , time = 27713 , queue_length = 5
Customer 420 left the queue after waiting for 27113 minutes
Begin_service --> caseid = 422 , time = 27713 , queue_length = 4
End_service --> caseid = 422 , time = 27773 , queue_length = 3
Begin_service --> caseid = 423 , time = 27773 , queue_length = 3
Customer joins queue --> caseid = 426 , time = 27793 , queue_length = 3
Next arrival time: 27831

Customer joins queue --> caseid = 427 , time = 27831 , queue_length = 4
Next arrival time: 27847
Customer joins queue --> caseid = 428 , time = 27847 , queue_length = 5
Next arrival time: 27860
Customer joins queue --> caseid = 429 , time = 27860 , queue_length = 6
Next arrival time: 27997
Customer balks --> caseid = 430 , time = 27997 , queue_length = 6
Next arrival time: 28017
End_service --> caseid = 423 , time = 28002 , queue_length = 6
Customer 424 left the queue after waiting for 27282 minutes
Begin_service --> caseid = 425 , time = 28002 , queue_length = 5
Customer joins queue --> caseid = 431 , time = 28017 , queue_length = 5
Next arrival time: 28021
Customer joins queue --> caseid = 432 , time = 28021 , queue_length = 6
Next arrival time: 28076
End_service --> caseid = 425 , time = 28062 , queue_length = 6
Customer 426 left the queue after waiting for 27342 minutes
Begin_service --> caseid = 427 , time = 28062 , queue_length = 5
Customer joins queue --> caseid = 433 , time = 28076 , queue_length = 5
Next arrival time: 28107
Customer joins queue --> caseid = 434 , time = 28107 , queue_length = 6
Next arrival time: 28129
End_service --> caseid = 427 , time = 28122 , queue_length = 6
Begin_service --> caseid = 428 , time = 28122 , queue_length = 6
Customer joins queue --> caseid = 435 , time = 28129 , queue_length = 6
Next arrival time: 28190
End_service --> caseid = 428 , time = 28182 , queue_length = 6
Customer 429 left the queue after waiting for 27462 minutes
Begin_service --> caseid = 431 , time = 28182 , queue_length = 5
Customer joins queue --> caseid = 436 , time = 28190 , queue_length = 5
Next arrival time: 28223
Customer joins queue --> caseid = 437 , time = 28223 , queue_length = 6
Next arrival time: 28346
Customer balks --> caseid = 438 , time = 28346 , queue_length = 6
Next arrival time: 28348
Customer balks --> caseid = 439 , time = 28348 , queue_length = 6
Next arrival time: 28352
Customer balks --> caseid = 440 , time = 28352 , queue_length = 6
Next arrival time: 28357
Customer balks --> caseid = 441 , time = 28357 , queue_length = 6
Next arrival time: 28500
End_service --> caseid = 431 , time = 28412 , queue_length = 6
Begin_service --> caseid = 432 , time = 28412 , queue_length = 6
End_service --> caseid = 432 , time = 28472 , queue_length = 5
Begin_service --> caseid = 433 , time = 28472 , queue_length = 5
Customer joins queue --> caseid = 442 , time = 28500 , queue_length = 5
Next arrival time: 28659
End_service --> caseid = 433 , time = 28570 , queue_length = 5
Begin_service --> caseid = 434 , time = 28570 , queue_length = 5
End_service --> caseid = 434 , time = 28630 , queue_length = 4
Customer 435 left the queue after waiting for 28150 minutes
Customer 436 left the queue after waiting for 28270 minutes
Customer 437 left the queue after waiting for 28390 minutes
Begin_service --> caseid = 442 , time = 28630 , queue_length = 1
Customer joins queue --> caseid = 443 , time = 28659 , queue_length = 1
Next arrival time: 28701
Customer joins queue --> caseid = 444 , time = 28701 , queue_length = 2
Next arrival time: 28714
Customer joins queue --> caseid = 445 , time = 28714 , queue_length = 3
Next arrival time: 28720

Customer joins queue --> caseid = 446 , time = 28720 , queue_length = 4
Next arrival time: 28768
Customer joins queue --> caseid = 447 , time = 28768 , queue_length = 5
Next arrival time: 28770
Customer joins queue --> caseid = 448 , time = 28770 , queue_length = 6
Next arrival time: 28812
End_service --> caseid = 442 , time = 28789 , queue_length = 6
Begin_service --> caseid = 443 , time = 28789 , queue_length = 6
Customer joins queue --> caseid = 449 , time = 28812 , queue_length = 6
Next arrival time: 28995
End_service --> caseid = 443 , time = 28871 , queue_length = 6
Begin_service --> caseid = 444 , time = 28871 , queue_length = 6
End_service --> caseid = 444 , time = 28931 , queue_length = 5
Customer 445 left the queue after waiting for 28331 minutes
Begin_service --> caseid = 446 , time = 28931 , queue_length = 4
Customer joins queue --> caseid = 450 , time = 28995 , queue_length = 4
Next arrival time: 29001
Customer joins queue --> caseid = 451 , time = 29001 , queue_length = 5
Next arrival time: 29063
End_service --> caseid = 446 , time = 29033 , queue_length = 5
Begin_service --> caseid = 447 , time = 29033 , queue_length = 5
Customer joins queue --> caseid = 452 , time = 29063 , queue_length = 5
Next arrival time: 29353
End_service --> caseid = 447 , time = 29093 , queue_length = 5
Begin_service --> caseid = 448 , time = 29093 , queue_length = 5
Customer joins queue --> caseid = 453 , time = 29353 , queue_length = 5
Next arrival time: 29391
Customer joins queue --> caseid = 454 , time = 29391 , queue_length = 6
Next arrival time: 29423
End_service --> caseid = 448 , time = 29393 , queue_length = 6
Begin_service --> caseid = 449 , time = 29393 , queue_length = 6
Customer joins queue --> caseid = 455 , time = 29423 , queue_length = 6
Next arrival time: 29513
End_service --> caseid = 449 , time = 29453 , queue_length = 6
Begin_service --> caseid = 450 , time = 29453 , queue_length = 6
End_service --> caseid = 450 , time = 29513 , queue_length = 5
Customer joins queue --> caseid = 456 , time = 29513 , queue_length = 6
Next arrival time: 29733
Customer 451 left the queue after waiting for 28793 minutes
Begin_service --> caseid = 452 , time = 29513 , queue_length = 5
End_service --> caseid = 452 , time = 29573 , queue_length = 4
Begin_service --> caseid = 453 , time = 29573 , queue_length = 4
End_service --> caseid = 453 , time = 29685 , queue_length = 3
Customer 454 left the queue after waiting for 29325 minutes
Begin_service --> caseid = 455 , time = 29685 , queue_length = 2
Customer joins queue --> caseid = 457 , time = 29733 , queue_length = 2
Next arrival time: 29750
Customer joins queue --> caseid = 458 , time = 29750 , queue_length = 3
Next arrival time: 29937
End_service --> caseid = 455 , time = 29856 , queue_length = 3
Customer 456 left the queue after waiting for 29496 minutes
Customer 457 left the queue after waiting for 29616 minutes
Begin_service --> caseid = 458 , time = 29856 , queue_length = 1
Customer joins queue --> caseid = 459 , time = 29937 , queue_length = 1
Next arrival time: 30053
End_service --> caseid = 458 , time = 30012 , queue_length = 1
Begin_service --> caseid = 459 , time = 30012 , queue_length = 1
Customer joins queue --> caseid = 460 , time = 30053 , queue_length = 1
Next arrival time: 30081
End_service --> caseid = 459 , time = 30072 , queue_length = 1

Begin_service --> caseid = 460 , time = 30072 , queue_length = 1
Customer joins queue --> caseid = 461 , time = 30081 , queue_length = 1
Next arrival time: 30103
Customer joins queue --> caseid = 462 , time = 30103 , queue_length = 2
Next arrival time: 30108
Customer joins queue --> caseid = 463 , time = 30108 , queue_length = 3
Next arrival time: 30171
End_service --> caseid = 460 , time = 30132 , queue_length = 3
Begin_service --> caseid = 461 , time = 30132 , queue_length = 3
Customer joins queue --> caseid = 464 , time = 30171 , queue_length = 3
Next arrival time: 30361
End_service --> caseid = 461 , time = 30192 , queue_length = 3
Begin_service --> caseid = 462 , time = 30192 , queue_length = 3
End_service --> caseid = 462 , time = 30252 , queue_length = 2
Begin_service --> caseid = 463 , time = 30252 , queue_length = 2
End_service --> caseid = 463 , time = 30312 , queue_length = 1
Begin_service --> caseid = 464 , time = 30312 , queue_length = 1
Customer joins queue --> caseid = 465 , time = 30361 , queue_length = 1
Next arrival time: 30438
Customer joins queue --> caseid = 466 , time = 30438 , queue_length = 2
Next arrival time: 30440
Customer joins queue --> caseid = 467 , time = 30440 , queue_length = 3
Next arrival time: 30457
Customer joins queue --> caseid = 468 , time = 30457 , queue_length = 4
Next arrival time: 30571
End_service --> caseid = 464 , time = 30460 , queue_length = 4
Customer 465 left the queue after waiting for 29980 minutes
Begin_service --> caseid = 466 , time = 30460 , queue_length = 3
End_service --> caseid = 466 , time = 30520 , queue_length = 2
Customer 467 left the queue after waiting for 30280 minutes
Customer 468 left the queue after waiting for 30400 minutes
Customer joins queue --> caseid = 469 , time = 30571 , queue_length = 1
Next arrival time: 30582
Begin_service --> caseid = 469 , time = 30571 , queue_length = 1
Customer joins queue --> caseid = 470 , time = 30582 , queue_length = 1
Next arrival time: 30644
End_service --> caseid = 469 , time = 30636 , queue_length = 1
Customer 470 left the queue after waiting for 30516 minutes
Customer joins queue --> caseid = 471 , time = 30644 , queue_length = 1
Next arrival time: 30658
Begin_service --> caseid = 471 , time = 30644 , queue_length = 1
Customer joins queue --> caseid = 472 , time = 30658 , queue_length = 1
Next arrival time: 30669
Customer joins queue --> caseid = 473 , time = 30669 , queue_length = 2
Next arrival time: 30679
Customer joins queue --> caseid = 474 , time = 30679 , queue_length = 3
Next arrival time: 30736
End_service --> caseid = 471 , time = 30730 , queue_length = 3
Customer 472 left the queue after waiting for 30370 minutes
Begin_service --> caseid = 473 , time = 30730 , queue_length = 2
Customer joins queue --> caseid = 475 , time = 30736 , queue_length = 2
Next arrival time: 30784
Customer joins queue --> caseid = 476 , time = 30784 , queue_length = 3
Next arrival time: 30797
Customer joins queue --> caseid = 477 , time = 30797 , queue_length = 4
Next arrival time: 30900
Customer joins queue --> caseid = 478 , time = 30900 , queue_length = 5
Next arrival time: 30906
Customer joins queue --> caseid = 479 , time = 30906 , queue_length = 6
Next arrival time: 30907

Customer balks --> caseid = 480 , time = 30907 , queue_length = 6
Next arrival time: 30956
Customer balks --> caseid = 481 , time = 30956 , queue_length = 6
Next arrival time: 31088
End_service --> caseid = 473 , time = 30996 , queue_length = 6
Begin_service --> caseid = 474 , time = 30996 , queue_length = 6
End_service --> caseid = 474 , time = 31056 , queue_length = 5
Customer 475 left the queue after waiting for 30456 minutes
Begin_service --> caseid = 476 , time = 31056 , queue_length = 4
Customer joins queue --> caseid = 482 , time = 31088 , queue_length = 4
Next arrival time: 31096
Customer joins queue --> caseid = 483 , time = 31096 , queue_length = 5
Next arrival time: 31225
End_service --> caseid = 476 , time = 31116 , queue_length = 5
Begin_service --> caseid = 477 , time = 31116 , queue_length = 5
Customer joins queue --> caseid = 484 , time = 31225 , queue_length = 5
Next arrival time: 31243
Customer joins queue --> caseid = 485 , time = 31243 , queue_length = 6
Next arrival time: 31257
Customer balks --> caseid = 486 , time = 31257 , queue_length = 6
Next arrival time: 31276
Customer balks --> caseid = 487 , time = 31276 , queue_length = 6
Next arrival time: 31387
End_service --> caseid = 477 , time = 31322 , queue_length = 6
Customer 478 left the queue after waiting for 30602 minutes
Begin_service --> caseid = 479 , time = 31322 , queue_length = 5
End_service --> caseid = 479 , time = 31382 , queue_length = 4
Begin_service --> caseid = 482 , time = 31382 , queue_length = 4
Customer joins queue --> caseid = 488 , time = 31387 , queue_length = 4
Next arrival time: 31455
Customer joins queue --> caseid = 489 , time = 31455 , queue_length = 5
Next arrival time: 31557
End_service --> caseid = 482 , time = 31545 , queue_length = 5
Begin_service --> caseid = 483 , time = 31545 , queue_length = 5
Customer joins queue --> caseid = 490 , time = 31557 , queue_length = 5
Next arrival time: 31562
Customer joins queue --> caseid = 491 , time = 31562 , queue_length = 6
Next arrival time: 31714
End_service --> caseid = 483 , time = 31618 , queue_length = 6
Customer 484 left the queue after waiting for 30898 minutes
Customer 485 left the queue after waiting for 31018 minutes
Begin_service --> caseid = 488 , time = 31618 , queue_length = 4
End_service --> caseid = 488 , time = 31678 , queue_length = 3
Customer 489 left the queue after waiting for 31318 minutes
Begin_service --> caseid = 490 , time = 31678 , queue_length = 2
Customer joins queue --> caseid = 492 , time = 31714 , queue_length = 2
Next arrival time: 31915
End_service --> caseid = 490 , time = 31749 , queue_length = 2
Begin_service --> caseid = 491 , time = 31749 , queue_length = 2
End_service --> caseid = 491 , time = 31809 , queue_length = 1
Customer 492 left the queue after waiting for 31689 minutes
Customer joins queue --> caseid = 493 , time = 31915 , queue_length = 1
Next arrival time: 31939
Begin_service --> caseid = 493 , time = 31915 , queue_length = 1
Customer joins queue --> caseid = 494 , time = 31939 , queue_length = 1
Next arrival time: 31983
Customer joins queue --> caseid = 495 , time = 31983 , queue_length = 2
Next arrival time: 31994
Customer joins queue --> caseid = 496 , time = 31994 , queue_length = 3
Next arrival time: 32078

End_service --> caseid = 493 , time = 32006 , queue_length = 3
Begin_service --> caseid = 494 , time = 32006 , queue_length = 3
Customer joins queue --> caseid = 497 , time = 32078 , queue_length = 3
Next arrival time: 32100
Customer joins queue --> caseid = 498 , time = 32100 , queue_length = 4
Next arrival time: 32211
End_service --> caseid = 494 , time = 32113 , queue_length = 4
Begin_service --> caseid = 495 , time = 32113 , queue_length = 4
Customer joins queue --> caseid = 499 , time = 32211 , queue_length = 4
Next arrival time: 32317
End_service --> caseid = 495 , time = 32212 , queue_length = 4
Begin_service --> caseid = 496 , time = 32212 , queue_length = 4
Customer joins queue --> caseid = 500 , time = 32317 , queue_length = 4
Next arrival time: 32321
Customer joins queue --> caseid = 501 , time = 32321 , queue_length = 5
Next arrival time: 32321
Customer joins queue --> caseid = 502 , time = 32321 , queue_length = 6
Next arrival time: 32396
End_service --> caseid = 496 , time = 32324 , queue_length = 6
Begin_service --> caseid = 497 , time = 32324 , queue_length = 6
Customer joins queue --> caseid = 503 , time = 32396 , queue_length = 6
Next arrival time: 32428
Customer balks --> caseid = 504 , time = 32428 , queue_length = 6
Next arrival time: 32535
End_service --> caseid = 497 , time = 32496 , queue_length = 6
Begin_service --> caseid = 498 , time = 32496 , queue_length = 6
Customer joins queue --> caseid = 505 , time = 32535 , queue_length = 6
Next arrival time: 32554
Customer balks --> caseid = 506 , time = 32554 , queue_length = 6
Next arrival time: 32568
Customer balks --> caseid = 507 , time = 32568 , queue_length = 6
Next arrival time: 32600
Customer balks --> caseid = 508 , time = 32600 , queue_length = 6
Next arrival time: 32644
End_service --> caseid = 498 , time = 32612 , queue_length = 6
Begin_service --> caseid = 499 , time = 32612 , queue_length = 6
Customer joins queue --> caseid = 509 , time = 32644 , queue_length = 6
Next arrival time: 32684
Customer balks --> caseid = 510 , time = 32684 , queue_length = 6
Next arrival time: 32892
End_service --> caseid = 499 , time = 32789 , queue_length = 6
Begin_service --> caseid = 500 , time = 32789 , queue_length = 6
Customer joins queue --> caseid = 511 , time = 32892 , queue_length = 6
Next arrival time: 32895
Customer balks --> caseid = 512 , time = 32895 , queue_length = 6
Next arrival time: 32904
Customer balks --> caseid = 513 , time = 32904 , queue_length = 6
Next arrival time: 32941
End_service --> caseid = 500 , time = 32941 , queue_length = 6
Customer balks --> caseid = 514 , time = 32941 , queue_length = 6
Next arrival time: 32995
Begin_service --> caseid = 501 , time = 32941 , queue_length = 6
Customer joins queue --> caseid = 515 , time = 32995 , queue_length = 6
Next arrival time: 33075
End_service --> caseid = 501 , time = 33001 , queue_length = 6
Begin_service --> caseid = 502 , time = 33001 , queue_length = 6
Customer joins queue --> caseid = 516 , time = 33075 , queue_length = 6
Next arrival time: 33151
Customer balks --> caseid = 517 , time = 33151 , queue_length = 6
Next arrival time: 33259

Customer balks --> caseid = 518 , time = 33259 , queue_length = 6
Next arrival time: 33299
Customer balks --> caseid = 519 , time = 33299 , queue_length = 6
Next arrival time: 33303
End_service --> caseid = 502 , time = 33301 , queue_length = 6
Begin_service --> caseid = 503 , time = 33301 , queue_length = 6
Customer joins queue --> caseid = 520 , time = 33303 , queue_length = 6
Next arrival time: 33411
Customer balks --> caseid = 521 , time = 33411 , queue_length = 6
Next arrival time: 33460
End_service --> caseid = 503 , time = 33414 , queue_length = 6
Begin_service --> caseid = 505 , time = 33414 , queue_length = 6
Customer joins queue --> caseid = 522 , time = 33460 , queue_length = 6
Next arrival time: 33540
Customer balks --> caseid = 523 , time = 33540 , queue_length = 6
Next arrival time: 33557
Customer balks --> caseid = 524 , time = 33557 , queue_length = 6
Next arrival time: 33571
Customer balks --> caseid = 525 , time = 33571 , queue_length = 6
Next arrival time: 33617
End_service --> caseid = 505 , time = 33616 , queue_length = 6
Customer 509 left the queue after waiting for 32896 minutes
Begin_service --> caseid = 511 , time = 33616 , queue_length = 5
Customer joins queue --> caseid = 526 , time = 33617 , queue_length = 5
Next arrival time: 33620
Customer joins queue --> caseid = 527 , time = 33620 , queue_length = 6
Next arrival time: 33730
Customer balks --> caseid = 528 , time = 33730 , queue_length = 6
Next arrival time: 33808
End_service --> caseid = 511 , time = 33742 , queue_length = 6
Customer 515 left the queue after waiting for 33022 minutes
Begin_service --> caseid = 516 , time = 33742 , queue_length = 5
End_service --> caseid = 516 , time = 33802 , queue_length = 4
Begin_service --> caseid = 520 , time = 33802 , queue_length = 4
Customer joins queue --> caseid = 529 , time = 33808 , queue_length = 4
Next arrival time: 33822
Customer joins queue --> caseid = 530 , time = 33822 , queue_length = 5
Next arrival time: 33845
Customer joins queue --> caseid = 531 , time = 33845 , queue_length = 6
Next arrival time: 33854
Customer balks --> caseid = 532 , time = 33854 , queue_length = 6
Next arrival time: 33881
Customer balks --> caseid = 533 , time = 33881 , queue_length = 6
Next arrival time: 33965
Customer balks --> caseid = 534 , time = 33965 , queue_length = 6
Next arrival time: 34024
Customer balks --> caseid = 535 , time = 34024 , queue_length = 6
Next arrival time: 34149
End_service --> caseid = 520 , time = 34102 , queue_length = 6
Begin_service --> caseid = 522 , time = 34102 , queue_length = 6
Customer joins queue --> caseid = 536 , time = 34149 , queue_length = 6
Next arrival time: 34228
Customer balks --> caseid = 537 , time = 34228 , queue_length = 6
Next arrival time: 34262
Customer balks --> caseid = 538 , time = 34262 , queue_length = 6
Next arrival time: 34298
Customer balks --> caseid = 539 , time = 34298 , queue_length = 6
Next arrival time: 34390
End_service --> caseid = 522 , time = 34307 , queue_length = 6
Begin_service --> caseid = 526 , time = 34307 , queue_length = 6

Customer joins queue --> caseid = 540 , time = 34390 , queue_length = 6
Next arrival time: 34403
Customer balks --> caseid = 541 , time = 34403 , queue_length = 6
Next arrival time: 34419
Customer balks --> caseid = 542 , time = 34419 , queue_length = 6
Next arrival time: 34436
Customer balks --> caseid = 543 , time = 34436 , queue_length = 6
Next arrival time: 34622
End_service --> caseid = 526 , time = 34607 , queue_length = 6
Begin_service --> caseid = 527 , time = 34607 , queue_length = 6
Customer joins queue --> caseid = 544 , time = 34622 , queue_length = 6
Next arrival time: 34622
Customer balks --> caseid = 545 , time = 34622 , queue_length = 6
Next arrival time: 34670
End_service --> caseid = 527 , time = 34667 , queue_length = 6
Customer 529 left the queue after waiting for 33947 minutes
Begin_service --> caseid = 530 , time = 34667 , queue_length = 5
Customer joins queue --> caseid = 546 , time = 34670 , queue_length = 5
Next arrival time: 34757
Customer joins queue --> caseid = 547 , time = 34757 , queue_length = 6
Next arrival time: 34782
Customer balks --> caseid = 548 , time = 34782 , queue_length = 6
Next arrival time: 34832
End_service --> caseid = 530 , time = 34806 , queue_length = 6
Begin_service --> caseid = 531 , time = 34806 , queue_length = 6
Customer joins queue --> caseid = 549 , time = 34832 , queue_length = 6
Next arrival time: 34834
Customer balks --> caseid = 550 , time = 34834 , queue_length = 6
Next arrival time: 34857
Customer balks --> caseid = 551 , time = 34857 , queue_length = 6
Next arrival time: 34901
End_service --> caseid = 531 , time = 34883 , queue_length = 6
Begin_service --> caseid = 536 , time = 34883 , queue_length = 6
Customer joins queue --> caseid = 552 , time = 34901 , queue_length = 6
Next arrival time: 34946
Customer balks --> caseid = 553 , time = 34946 , queue_length = 6
Next arrival time: 35075
Customer balks --> caseid = 554 , time = 35075 , queue_length = 6
Next arrival time: 35143
End_service --> caseid = 536 , time = 35099 , queue_length = 6
Customer 540 left the queue after waiting for 34379 minutes
Begin_service --> caseid = 544 , time = 35099 , queue_length = 5
Customer joins queue --> caseid = 555 , time = 35143 , queue_length = 5
Next arrival time: 35196
End_service --> caseid = 544 , time = 35159 , queue_length = 5
Begin_service --> caseid = 546 , time = 35159 , queue_length = 5
Customer joins queue --> caseid = 556 , time = 35196 , queue_length = 5
Next arrival time: 35313
End_service --> caseid = 546 , time = 35228 , queue_length = 5
Begin_service --> caseid = 547 , time = 35228 , queue_length = 5
Customer joins queue --> caseid = 557 , time = 35313 , queue_length = 5
Next arrival time: 35397
Customer joins queue --> caseid = 558 , time = 35397 , queue_length = 6
Next arrival time: 35413
Customer balks --> caseid = 559 , time = 35413 , queue_length = 6
Next arrival time: 35473
Customer balks --> caseid = 560 , time = 35473 , queue_length = 6
Next arrival time: 35583
End_service --> caseid = 547 , time = 35528 , queue_length = 6
Customer 549 left the queue after waiting for 34808 minutes

```

Begin_service --> caseid = 552 , time = 35528 , queue_length = 5
Customer joins queue --> caseid = 561 , time = 35583 , queue_length = 5
Next arrival time: 35595
Customer joins queue --> caseid = 562 , time = 35595 , queue_length = 6
Next arrival time: 35719
Customer balks --> caseid = 563 , time = 35719 , queue_length = 6
Next arrival time: 35862
End_service --> caseid = 552 , time = 35828 , queue_length = 6
Customer 555 left the queue after waiting for 35108 minutes
Begin_service --> caseid = 556 , time = 35828 , queue_length = 5
Customer joins queue --> caseid = 564 , time = 35862 , queue_length = 5
Next arrival time: 35879
Customer joins queue --> caseid = 565 , time = 35879 , queue_length = 6
Next arrival time: 35973
Customer balks --> caseid = 566 , time = 35973 , queue_length = 6
Next arrival time: 35998
End_service --> caseid = 556 , time = 35986 , queue_length = 6
Customer 557 left the queue after waiting for 35266 minutes
Begin_service --> caseid = 558 , time = 35986 , queue_length = 5
Customer joins queue --> caseid = 567 , time = 35998 , queue_length = 5
Next arrival time: 36074

```

```

In [73]: #create text file for simulation output
simulation_trace_file_name = 'simulation-program-trace-' + simulation_file_iden
with open(simulation_trace_file_name, 'wt') as ftrace:
    for d in simulation_data:
        print(str(d), file = ftrace)
print()
print('simulation program trace written to file:',simulation_trace_file_name)

# convert list of tuples to list of lists
event_log_list = [list(element) for element in event_log]

# convert to pandas data frame
caseid_list = []
time_list = []
activity_list = []
for d in event_log_list:
    if d[0] > 0:
        caseid_list.append(d[0])
        time_list.append(d[1])
        activity_list.append(d[2])
event_log_df = pd.DataFrame({'caseid':caseid_list,
                             'time':time_list,
                             'activity':activity_list})

#save event log to CSV file
event_log_file_name = 'simulation-event-log-' + simulation_file_identifier + '
event_log_df.to_csv(event_log_file_name, index = False)
print()
print('event log written to file:',event_log_file_name)

simulation program trace written to file: simulation-program-trace-10-hours-1-
1-2-5-1-6-10.txt

event log written to file: simulation-event-log-10-hours-1-1-2-5-1-6-10.csv

```

```

In [74]: #inspect event log
event_log_df.head()

```

Out[74]:

	caseid	time	activity
0	1	11	arrival
1	1	11	join_queue
2	1	11	begin_service
3	2	69	arrival
4	2	69	join_queue

Simulation Summary and Summary Statistics

```
In [75]: avg_ticket = 5
sim_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='end_serv
lost_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='balk'])
barista_wages = 18 #per hour
sim_payroll = baristas * barista_wages * sim_hours

#print simulation results
print()
print('Simulation parameter settings:')
print(baristas, 'baristas/servers')
print(' Service time settings (in minutes)')
print('     minimum:',min_service_time)
print('     mean:    ',mean_service_time)
print('     maximum:',max_service_time)
print()
print('Customers set to arrive every', mean_inter_arrival_time, 'minute(s) on a
print('Customers will not join the queue/waiting line if it has',balk_queue_len
print('Customers will leave the queue/waiting line after waiting', max_wait_tim
print('The simulation is set to run for ', sim_hours,' hours (',60 * sim_hours,
print()
end_time = np.max(event_log_df["time"])
print('Results after ',end_time, ' seconds (', round(end_time/60, 2), ' minutes)
caseid_list = pd.unique(event_log_df['caseid'])
print(len(caseid_list), 'unique customers arrived')
print(len(event_log_df['activity'])[event_log_df['activity']=='join_queue']),'cu
print(len(event_log_df['activity'])[event_log_df['activity']=='balk']),'custome
print(len(event_log_df['activity'])[event_log_df['activity']=='renege']),'custor
print(len(event_log_df['activity'])[event_log_df['activity']=='begin_service']),
print(len(event_log_df['activity'])[event_log_df['activity']=='end_service']),'c
print(caseid_queue.qsize()),'customers were still in line at the end of the simu
print()
print(f'${sim_revenue:.2f} average simulation revenue (assuming ${avg_ticket} a
print(f'${lost_revenue:.2f} average lost revenue (balking & renegeing)')
print(f'${sim_payroll:.2f} simulation payroll costs')

# case-by-case logs are very useful for checking the logic of the simulation
case_by_case_event_file_name = 'simulation-program-case-by-case-events-' + sim
with open(case_by_case_event_file_name, 'wt') as fcasedata:
    lastcase_arrival_time = 0 # initialize for use with first case
    # create lists for storing time interval data
    inter_arrival_times = [] # computed across cases
    waiting_time = [] # computed within each case that has begun service
    service_time = [] # computed within each case that has ended service
    for thiscase in caseid_list:
        # select subset of rows for thiscase and use as a Pandas data frame
```

```

thiscase_events = event_log_df[['caseid','time','activity']][event_log_
print(file = fcasedata)
print('events for caseid',thiscase, file = fcasedata)
print(thiscase_events, file = fcasedata)
# compute inter-arrival times between cases
thiscase_arrival_time = thiscase_events.loc[thiscase_events['activity']
inter_arrival_time = thiscase_arrival_time - lastcase_arrival_time
inter_arrival_times.append(inter_arrival_time)
print(file = fcasedata)
print('time between arrivals (this case minus previous case):',inter_a
lastcase_arrival_time = thiscase_arrival_time # save for next case in
# compute waiting times within this case (must have begin_service event)
if thiscase_events.loc[thiscase_events['activity']=='begin_service'].sh
    thiscase_begin_service = thiscase_events.loc[thiscase_events['activ
    thiscase_join_queue = thiscase_arrival_time = thiscase_events.loc[
    thiscase_waiting_time = thiscase_begin_service - thiscase_join_que
    waiting_time.append(thiscase_waiting_time)
    print('waiting time for this case (time between joining queue and l
# compute service time within this case (must have end_service event/a
if thiscase_events.loc[thiscase_events['activity']=='end_service'].shap
    thiscase_end_service = thiscase_events.loc[thiscase_events['activi
    thiscase_service_time = thiscase_end_service - thiscase_begin_serv
    service_time.append(thiscase_service_time)
    print('service time for this case (time between beginning and endi

print()
print('Summary statistics for customer inter-arrival times:')
print('  Minimum: ',round(np.min(inter_arrival_times),2), ' seconds (' ,round(n
print('  Mean:      ',round(np.average(inter_arrival_times),2), ' seconds (' ,rou
print('  Maximum: ',round(np.max(inter_arrival_times),2), ' seconds (' ,round(n
print()
print('Summary statistics for customer wait times:')
print('  Minimum: ',round(np.min(waiting_time),2), ' seconds (' ,round(np.min(v
print('  Mean:      ',round(np.average(waiting_time),2), ' seconds (' ,round(np.
print('  Maximum: ',round(np.max(waiting_time),2), ' seconds (' ,round(np.max(v
print()
print('Summary statistics for service times:')
print('  Minimum: ',round(np.min(service_time),2), ' seconds (' ,round(np.min(s
print('  Mean:      ',round(np.average(service_time),2), ' seconds (' ,round(np.
print('  Maximum: ',round(np.max(service_time),2), ' seconds (' ,round(np.max(s

```

Simulation parameter settings:

1 baristas/servers

Service time settings (in minutes)

minimum: 1

mean: 2

maximum: 5

Customers set to arrive every 1 minute(s) on average

Customers will not join the queue/waiting line if it has 6 customers in it (balking)

Customers will leave the queue/waiting line after waiting 10 minute(s) (reneging)

The simulation is set to run for 10 hours (600 minutes)

Results after 35998 seconds (599.97 minutes, 10.0 hours):

567 unique customers arrived

407 customers joined the queue for service

160 customers balked (lost business)

117 customers reneged (left queue, lost business)

285 customers began service

284 customers ended service

5 customers were still in line at the end of the simulation

\$1420.00 average simulation revenue (assuming \$5 average ticket)

\$1385.00 average lost revenue (balking & reneging)

\$180.00 simulation payroll costs

Summary statistics for customer inter-arrival times:

Minimum: 0 seconds (0.0 minutes)

Mean: 63.49 seconds (1.06 minutes)

Maximum: 476 seconds (7.93 minutes)

Summary statistics for customer wait times:

Minimum: 0 seconds (0.0 minutes)

Mean: 359.52 seconds (5.99 minutes)

Maximum: 1037 seconds (17.28 minutes)

Summary statistics for service times:

Minimum: 60 seconds (1.0 minutes)

Mean: 120.79 seconds (2.01 minutes)

Maximum: 300 seconds (5.0 minutes)

Observations:

From the simulation test, we determine more baristas are needed to meet the flow of new customers as at the set inter arrival time of 1 minute. Maximum wait time of 18.3 minutes far exceeded the 10 minute wait tolerance of 30% of customer base.

Morning Shift Simulation 6-10 A.M.

Define Staffing, Wait, Balking, Reneging

```
In [76]: #define staff
baristas = 3

#define service times (in minutes)
min_service_time = 1
mean_service_time = 2
max_service_time = 5

#define wait times (in minutes)
max_wait_time = 10

#define arrival pace (in minutes)
mean_inter_arrival_time = 1

#define balking tolerance (number of people in line)
balk_queue_length = 10
```

```
In [77]: #enable reproducible results
obtain_reproducible_results = True

#set simulation parameters
sim_hours = 4
fixed_sim_time = sim_hours * 60 * 60 #convert hours to seconds

#create parameter strings
parameter_strings_list = [str(sim_hours), 'hours',
                          str(baristas), str(min_service_time),
                          str(mean_service_time), str(max_service_time),
                          str(mean_inter_arrival_time), str(balk_queue_length),

separator = '_'
simulation_file_identifier = separator.join(parameter_strings_list)
```

```
In [78]: #set random seed
if obtain_reproducible_results:
    np.random.seed(9876)

#set simulation trace monitoring
simulation_data = []
this_trace_monitor = partial(trace_monitor, simulation_data)

env = simpy.Environment()
trace(env, this_trace_monitor)

env.process(test_process(env))

#set FIFO queue for caseid values
caseid_queue = queue.Queue()

#set limits on baristas resource
baristas_on_shift = simpy.Resource(env, capacity = baristas)
caseid = -1

#create event log tuple
event_log = [(caseid, 0, 'null_start_simulation')]
env.process(event_log_append(env, caseid, env.now, 'start_simulation', event_log))

#call customer arrival generator to start simulation
env.process(arrival(env, caseid, caseid_queue, event_log))
```

```
env.run(until = fixed_sim_time)
```

Out[78]: <Process(test_process) object at 0x7feb88f82ca0>

Out[78]: <Process(event_log_append) object at 0x7feb88f82850>

Out[78]: <Process(arrival) object at 0x7feb869edf70>

Next arrival time: 11
Customer joins queue --> caseid = 1 , time = 11 , queue_length = 1
Next arrival time: 69
Begin_service --> caseid = 1 , time = 11 , queue_length = 1
Customer joins queue --> caseid = 2 , time = 69 , queue_length = 1
Next arrival time: 156
Begin_service --> caseid = 2 , time = 69 , queue_length = 1
End_service --> caseid = 2 , time = 155 , queue_length = 0
Customer joins queue --> caseid = 3 , time = 156 , queue_length = 1
Next arrival time: 162
Begin_service --> caseid = 3 , time = 156 , queue_length = 1
Customer joins queue --> caseid = 4 , time = 162 , queue_length = 1
Next arrival time: 171
Begin_service --> caseid = 4 , time = 162 , queue_length = 1
Customer joins queue --> caseid = 5 , time = 171 , queue_length = 1
Next arrival time: 212
Customer joins queue --> caseid = 6 , time = 212 , queue_length = 2
Next arrival time: 224
Customer joins queue --> caseid = 7 , time = 224 , queue_length = 3
Next arrival time: 234
End_service --> caseid = 3 , time = 230 , queue_length = 3
Begin_service --> caseid = 5 , time = 230 , queue_length = 3
Customer joins queue --> caseid = 8 , time = 234 , queue_length = 3
Next arrival time: 255
Customer joins queue --> caseid = 9 , time = 255 , queue_length = 4
Next arrival time: 264
Customer joins queue --> caseid = 10 , time = 264 , queue_length = 5
Next arrival time: 367
End_service --> caseid = 1 , time = 289 , queue_length = 5
Begin_service --> caseid = 6 , time = 289 , queue_length = 5
End_service --> caseid = 5 , time = 290 , queue_length = 4
Begin_service --> caseid = 7 , time = 290 , queue_length = 4
Customer joins queue --> caseid = 11 , time = 367 , queue_length = 4
Next arrival time: 490
End_service --> caseid = 7 , time = 430 , queue_length = 4
Begin_service --> caseid = 8 , time = 430 , queue_length = 4
End_service --> caseid = 6 , time = 443 , queue_length = 3
Begin_service --> caseid = 9 , time = 443 , queue_length = 3
End_service --> caseid = 4 , time = 462 , queue_length = 2
Begin_service --> caseid = 10 , time = 462 , queue_length = 2
Customer joins queue --> caseid = 12 , time = 490 , queue_length = 2
Next arrival time: 527
End_service --> caseid = 10 , time = 522 , queue_length = 2
Begin_service --> caseid = 11 , time = 522 , queue_length = 2
Customer joins queue --> caseid = 13 , time = 527 , queue_length = 2
Next arrival time: 630
End_service --> caseid = 8 , time = 608 , queue_length = 2
Begin_service --> caseid = 12 , time = 608 , queue_length = 2
End_service --> caseid = 9 , time = 615 , queue_length = 1
Begin_service --> caseid = 13 , time = 615 , queue_length = 1
Customer joins queue --> caseid = 14 , time = 630 , queue_length = 1
Next arrival time: 698
Customer joins queue --> caseid = 15 , time = 698 , queue_length = 2
Next arrival time: 747
End_service --> caseid = 13 , time = 706 , queue_length = 2
Begin_service --> caseid = 14 , time = 706 , queue_length = 2
End_service --> caseid = 12 , time = 741 , queue_length = 1
Begin_service --> caseid = 15 , time = 741 , queue_length = 1
Customer joins queue --> caseid = 16 , time = 747 , queue_length = 1
Next arrival time: 758

Customer joins queue --> caseid = 17 , time = 758 , queue_length = 2
Next arrival time: 884
End_service --> caseid = 11 , time = 811 , queue_length = 2
Begin_service --> caseid = 16 , time = 811 , queue_length = 2
End_service --> caseid = 15 , time = 858 , queue_length = 1
Begin_service --> caseid = 17 , time = 858 , queue_length = 1
Customer joins queue --> caseid = 18 , time = 884 , queue_length = 1
Next arrival time: 942
End_service --> caseid = 17 , time = 918 , queue_length = 1
Begin_service --> caseid = 18 , time = 918 , queue_length = 1
Customer joins queue --> caseid = 19 , time = 942 , queue_length = 1
Next arrival time: 1009
End_service --> caseid = 14 , time = 1006 , queue_length = 1
Begin_service --> caseid = 19 , time = 1006 , queue_length = 1
Customer joins queue --> caseid = 20 , time = 1009 , queue_length = 1
Next arrival time: 1108
End_service --> caseid = 16 , time = 1059 , queue_length = 1
Begin_service --> caseid = 20 , time = 1059 , queue_length = 1
End_service --> caseid = 19 , time = 1066 , queue_length = 0
End_service --> caseid = 18 , time = 1076 , queue_length = 0
Customer joins queue --> caseid = 21 , time = 1108 , queue_length = 1
Next arrival time: 1126
Customer 21 left the queue after waiting for 988 minutes
Customer joins queue --> caseid = 22 , time = 1126 , queue_length = 1
Next arrival time: 1602
Customer 22 left the queue after waiting for 1006 minutes
End_service --> caseid = 20 , time = 1225 , queue_length = 0
Customer joins queue --> caseid = 23 , time = 1602 , queue_length = 1
Next arrival time: 1636
Begin_service --> caseid = 23 , time = 1602 , queue_length = 1
Customer joins queue --> caseid = 24 , time = 1636 , queue_length = 1
Next arrival time: 1704
Customer 24 left the queue after waiting for 1516 minutes
End_service --> caseid = 23 , time = 1680 , queue_length = 0
Customer joins queue --> caseid = 25 , time = 1704 , queue_length = 1
Next arrival time: 1777
Customer 25 left the queue after waiting for 1584 minutes
Customer joins queue --> caseid = 26 , time = 1777 , queue_length = 1
Next arrival time: 1880
Customer 26 left the queue after waiting for 1657 minutes
Customer joins queue --> caseid = 27 , time = 1880 , queue_length = 1
Next arrival time: 1887
Customer 27 left the queue after waiting for 1760 minutes
Customer joins queue --> caseid = 28 , time = 1887 , queue_length = 1
Next arrival time: 1893
Begin_service --> caseid = 28 , time = 1887 , queue_length = 1
Customer joins queue --> caseid = 29 , time = 1893 , queue_length = 1
Next arrival time: 1950
Begin_service --> caseid = 29 , time = 1893 , queue_length = 1
Customer joins queue --> caseid = 30 , time = 1950 , queue_length = 1
Next arrival time: 2001
Customer 30 left the queue after waiting for 1830 minutes
Customer joins queue --> caseid = 31 , time = 2001 , queue_length = 1
Next arrival time: 2018
Customer 31 left the queue after waiting for 1881 minutes
Customer joins queue --> caseid = 32 , time = 2018 , queue_length = 1
Next arrival time: 2184
Begin_service --> caseid = 32 , time = 2018 , queue_length = 1
End_service --> caseid = 29 , time = 2056 , queue_length = 0
End_service --> caseid = 32 , time = 2078 , queue_length = 0

Customer joins queue --> caseid = 33 , time = 2184 , queue_length = 1
Next arrival time: 2251
Begin_service --> caseid = 33 , time = 2184 , queue_length = 1
End_service --> caseid = 28 , time = 2187 , queue_length = 0
End_service --> caseid = 33 , time = 2244 , queue_length = 0
Customer joins queue --> caseid = 34 , time = 2251 , queue_length = 1
Next arrival time: 2289
Customer 34 left the queue after waiting for 2131 minutes
Customer joins queue --> caseid = 35 , time = 2289 , queue_length = 1
Next arrival time: 2392
Begin_service --> caseid = 35 , time = 2289 , queue_length = 1
End_service --> caseid = 35 , time = 2349 , queue_length = 0
Customer joins queue --> caseid = 36 , time = 2392 , queue_length = 1
Next arrival time: 2418
Begin_service --> caseid = 36 , time = 2392 , queue_length = 1
Customer joins queue --> caseid = 37 , time = 2418 , queue_length = 1
Next arrival time: 2459
Begin_service --> caseid = 37 , time = 2418 , queue_length = 1
Customer joins queue --> caseid = 38 , time = 2459 , queue_length = 1
Next arrival time: 2505
Begin_service --> caseid = 38 , time = 2459 , queue_length = 1
End_service --> caseid = 36 , time = 2463 , queue_length = 0
Customer joins queue --> caseid = 39 , time = 2505 , queue_length = 1
Next arrival time: 2522
Begin_service --> caseid = 39 , time = 2505 , queue_length = 1
End_service --> caseid = 37 , time = 2511 , queue_length = 0
Customer joins queue --> caseid = 40 , time = 2522 , queue_length = 1
Next arrival time: 2633
Customer 40 left the queue after waiting for 2402 minutes
Customer joins queue --> caseid = 41 , time = 2633 , queue_length = 1
Next arrival time: 2660
Begin_service --> caseid = 41 , time = 2633 , queue_length = 1
Customer joins queue --> caseid = 42 , time = 2660 , queue_length = 1
Next arrival time: 2688
Customer joins queue --> caseid = 43 , time = 2688 , queue_length = 2
Next arrival time: 2692
Customer joins queue --> caseid = 44 , time = 2692 , queue_length = 3
Next arrival time: 2840
End_service --> caseid = 41 , time = 2693 , queue_length = 3
Begin_service --> caseid = 42 , time = 2693 , queue_length = 3
End_service --> caseid = 38 , time = 2709 , queue_length = 2
Begin_service --> caseid = 43 , time = 2709 , queue_length = 2
End_service --> caseid = 42 , time = 2753 , queue_length = 1
Begin_service --> caseid = 44 , time = 2753 , queue_length = 1
End_service --> caseid = 43 , time = 2795 , queue_length = 0
End_service --> caseid = 39 , time = 2805 , queue_length = 0
End_service --> caseid = 44 , time = 2831 , queue_length = 0
Customer joins queue --> caseid = 45 , time = 2840 , queue_length = 1
Next arrival time: 2858
Begin_service --> caseid = 45 , time = 2840 , queue_length = 1
Customer joins queue --> caseid = 46 , time = 2858 , queue_length = 1
Next arrival time: 2892
Begin_service --> caseid = 46 , time = 2858 , queue_length = 1
Customer joins queue --> caseid = 47 , time = 2892 , queue_length = 1
Next arrival time: 2894
Begin_service --> caseid = 47 , time = 2892 , queue_length = 1
Customer joins queue --> caseid = 48 , time = 2894 , queue_length = 1
Next arrival time: 2939
Customer joins queue --> caseid = 49 , time = 2939 , queue_length = 2
Next arrival time: 2985

Customer joins queue --> caseid = 50 , time = 2985 , queue_length = 3
Next arrival time: 3066
End_service --> caseid = 47 , time = 3016 , queue_length = 3
Begin_service --> caseid = 48 , time = 3016 , queue_length = 3
End_service --> caseid = 45 , time = 3050 , queue_length = 2
Begin_service --> caseid = 49 , time = 3050 , queue_length = 2
Customer joins queue --> caseid = 51 , time = 3066 , queue_length = 2
Next arrival time: 3187
End_service --> caseid = 48 , time = 3093 , queue_length = 2
Begin_service --> caseid = 50 , time = 3093 , queue_length = 2
End_service --> caseid = 46 , time = 3118 , queue_length = 1
Begin_service --> caseid = 51 , time = 3118 , queue_length = 1
End_service --> caseid = 50 , time = 3153 , queue_length = 0
Customer joins queue --> caseid = 52 , time = 3187 , queue_length = 1
Next arrival time: 3189
Begin_service --> caseid = 52 , time = 3187 , queue_length = 1
Customer joins queue --> caseid = 53 , time = 3189 , queue_length = 1
Next arrival time: 3234
Customer joins queue --> caseid = 54 , time = 3234 , queue_length = 2
Next arrival time: 3289
End_service --> caseid = 51 , time = 3248 , queue_length = 2
Begin_service --> caseid = 53 , time = 3248 , queue_length = 2
Customer joins queue --> caseid = 55 , time = 3289 , queue_length = 2
Next arrival time: 3312
End_service --> caseid = 49 , time = 3297 , queue_length = 2
Begin_service --> caseid = 54 , time = 3297 , queue_length = 2
Customer joins queue --> caseid = 56 , time = 3312 , queue_length = 2
Next arrival time: 3328
Customer joins queue --> caseid = 57 , time = 3328 , queue_length = 3
Next arrival time: 3347
End_service --> caseid = 52 , time = 3333 , queue_length = 3
Customer 55 left the queue after waiting for 2973 minutes
Customer 56 left the queue after waiting for 3093 minutes
Customer 57 left the queue after waiting for 3213 minutes
Customer joins queue --> caseid = 58 , time = 3347 , queue_length = 1
Next arrival time: 3556
Begin_service --> caseid = 58 , time = 3347 , queue_length = 1
End_service --> caseid = 54 , time = 3357 , queue_length = 0
End_service --> caseid = 58 , time = 3407 , queue_length = 0
End_service --> caseid = 53 , time = 3408 , queue_length = 0
Customer joins queue --> caseid = 59 , time = 3556 , queue_length = 1
Next arrival time: 3625
Begin_service --> caseid = 59 , time = 3556 , queue_length = 1
End_service --> caseid = 59 , time = 3616 , queue_length = 0
Customer joins queue --> caseid = 60 , time = 3625 , queue_length = 1
Next arrival time: 3680
Begin_service --> caseid = 60 , time = 3625 , queue_length = 1
Customer joins queue --> caseid = 61 , time = 3680 , queue_length = 1
Next arrival time: 3682
Begin_service --> caseid = 61 , time = 3680 , queue_length = 1
Customer joins queue --> caseid = 62 , time = 3682 , queue_length = 1
Next arrival time: 3703
Customer 62 left the queue after waiting for 3562 minutes
End_service --> caseid = 60 , time = 3685 , queue_length = 0
Customer joins queue --> caseid = 63 , time = 3703 , queue_length = 1
Next arrival time: 3792
Begin_service --> caseid = 63 , time = 3703 , queue_length = 1
End_service --> caseid = 61 , time = 3740 , queue_length = 0
Customer joins queue --> caseid = 64 , time = 3792 , queue_length = 1
Next arrival time: 3907

Begin_service --> caseid = 64 , time = 3792 , queue_length = 1
Customer joins queue --> caseid = 65 , time = 3907 , queue_length = 1
Next arrival time: 3925
Begin_service --> caseid = 65 , time = 3907 , queue_length = 1
Customer joins queue --> caseid = 66 , time = 3925 , queue_length = 1
Next arrival time: 3961
Customer joins queue --> caseid = 67 , time = 3961 , queue_length = 2
Next arrival time: 3991
End_service --> caseid = 63 , time = 3962 , queue_length = 2
Begin_service --> caseid = 66 , time = 3962 , queue_length = 2
Customer joins queue --> caseid = 68 , time = 3991 , queue_length = 2
Next arrival time: 4016
Customer joins queue --> caseid = 69 , time = 4016 , queue_length = 3
Next arrival time: 4104
End_service --> caseid = 64 , time = 4042 , queue_length = 3
Begin_service --> caseid = 67 , time = 4042 , queue_length = 3
End_service --> caseid = 66 , time = 4072 , queue_length = 2
Begin_service --> caseid = 68 , time = 4072 , queue_length = 2
Customer joins queue --> caseid = 70 , time = 4104 , queue_length = 2
Next arrival time: 4311
End_service --> caseid = 65 , time = 4131 , queue_length = 2
Begin_service --> caseid = 69 , time = 4131 , queue_length = 2
End_service --> caseid = 69 , time = 4191 , queue_length = 1
Begin_service --> caseid = 70 , time = 4191 , queue_length = 1
End_service --> caseid = 67 , time = 4201 , queue_length = 0
Customer joins queue --> caseid = 71 , time = 4311 , queue_length = 1
Next arrival time: 4543
Begin_service --> caseid = 71 , time = 4311 , queue_length = 1
End_service --> caseid = 71 , time = 4371 , queue_length = 0
End_service --> caseid = 68 , time = 4372 , queue_length = 0
End_service --> caseid = 70 , time = 4491 , queue_length = 0
Customer joins queue --> caseid = 72 , time = 4543 , queue_length = 1
Next arrival time: 4555
Begin_service --> caseid = 72 , time = 4543 , queue_length = 1
Customer joins queue --> caseid = 73 , time = 4555 , queue_length = 1
Next arrival time: 4668
Begin_service --> caseid = 73 , time = 4555 , queue_length = 1
End_service --> caseid = 72 , time = 4603 , queue_length = 0
End_service --> caseid = 73 , time = 4628 , queue_length = 0
Customer joins queue --> caseid = 74 , time = 4668 , queue_length = 1
Next arrival time: 4674
Customer 74 left the queue after waiting for 4548 minutes
Customer joins queue --> caseid = 75 , time = 4674 , queue_length = 1
Next arrival time: 4678
Begin_service --> caseid = 75 , time = 4674 , queue_length = 1
Customer joins queue --> caseid = 76 , time = 4678 , queue_length = 1
Next arrival time: 4789
Customer 76 left the queue after waiting for 4558 minutes
End_service --> caseid = 75 , time = 4778 , queue_length = 0
Customer joins queue --> caseid = 77 , time = 4789 , queue_length = 1
Next arrival time: 4802
Begin_service --> caseid = 77 , time = 4789 , queue_length = 1
Customer joins queue --> caseid = 78 , time = 4802 , queue_length = 1
Next arrival time: 4857
Begin_service --> caseid = 78 , time = 4802 , queue_length = 1
Customer joins queue --> caseid = 79 , time = 4857 , queue_length = 1
Next arrival time: 4992
Begin_service --> caseid = 79 , time = 4857 , queue_length = 1
End_service --> caseid = 78 , time = 4862 , queue_length = 0
End_service --> caseid = 77 , time = 4893 , queue_length = 0

End_service --> caseid = 79 , time = 4917 , queue_length = 0
Customer joins queue --> caseid = 80 , time = 4992 , queue_length = 1
Next arrival time: 4994
Begin_service --> caseid = 80 , time = 4992 , queue_length = 1
Customer joins queue --> caseid = 81 , time = 4994 , queue_length = 1
Next arrival time: 5101
Customer 81 left the queue after waiting for 4874 minutes
Customer joins queue --> caseid = 82 , time = 5101 , queue_length = 1
Next arrival time: 5198
Begin_service --> caseid = 82 , time = 5101 , queue_length = 1
End_service --> caseid = 80 , time = 5182 , queue_length = 0
Customer joins queue --> caseid = 83 , time = 5198 , queue_length = 1
Next arrival time: 5336
Begin_service --> caseid = 83 , time = 5198 , queue_length = 1
End_service --> caseid = 83 , time = 5258 , queue_length = 0
End_service --> caseid = 82 , time = 5317 , queue_length = 0
Customer joins queue --> caseid = 84 , time = 5336 , queue_length = 1
Next arrival time: 5379
Customer 84 left the queue after waiting for 5216 minutes
Customer joins queue --> caseid = 85 , time = 5379 , queue_length = 1
Next arrival time: 5381
Begin_service --> caseid = 85 , time = 5379 , queue_length = 1
Customer joins queue --> caseid = 86 , time = 5381 , queue_length = 1
Next arrival time: 5388
Customer 86 left the queue after waiting for 5261 minutes
Customer joins queue --> caseid = 87 , time = 5388 , queue_length = 1
Next arrival time: 5479
Begin_service --> caseid = 87 , time = 5388 , queue_length = 1
End_service --> caseid = 87 , time = 5448 , queue_length = 0
Customer joins queue --> caseid = 88 , time = 5479 , queue_length = 1
Next arrival time: 5482
Begin_service --> caseid = 88 , time = 5479 , queue_length = 1
Customer joins queue --> caseid = 89 , time = 5482 , queue_length = 1
Next arrival time: 5501
Begin_service --> caseid = 89 , time = 5482 , queue_length = 1
Customer joins queue --> caseid = 90 , time = 5501 , queue_length = 1
Next arrival time: 5526
Customer joins queue --> caseid = 91 , time = 5526 , queue_length = 2
Next arrival time: 5620
End_service --> caseid = 88 , time = 5539 , queue_length = 2
Begin_service --> caseid = 90 , time = 5539 , queue_length = 2
End_service --> caseid = 89 , time = 5608 , queue_length = 1
Customer 91 left the queue after waiting for 5488 minutes
Customer joins queue --> caseid = 92 , time = 5620 , queue_length = 1
Next arrival time: 5666
Begin_service --> caseid = 92 , time = 5620 , queue_length = 1
End_service --> caseid = 90 , time = 5637 , queue_length = 0
Customer joins queue --> caseid = 93 , time = 5666 , queue_length = 1
Next arrival time: 5731
Begin_service --> caseid = 93 , time = 5666 , queue_length = 1
End_service --> caseid = 85 , time = 5679 , queue_length = 0
End_service --> caseid = 92 , time = 5723 , queue_length = 0
Customer joins queue --> caseid = 94 , time = 5731 , queue_length = 1
Next arrival time: 5774
Begin_service --> caseid = 94 , time = 5731 , queue_length = 1
Customer joins queue --> caseid = 95 , time = 5774 , queue_length = 1
Next arrival time: 5813
Customer 95 left the queue after waiting for 5654 minutes
End_service --> caseid = 93 , time = 5799 , queue_length = 0
Customer joins queue --> caseid = 96 , time = 5813 , queue_length = 1

Next arrival time: 5828
Customer 96 left the queue after waiting for 5693 minutes
Customer joins queue --> caseid = 97 , time = 5828 , queue_length = 1
Next arrival time: 5927
Begin_service --> caseid = 97 , time = 5828 , queue_length = 1
End_service --> caseid = 94 , time = 5879 , queue_length = 0
End_service --> caseid = 97 , time = 5888 , queue_length = 0
Customer joins queue --> caseid = 98 , time = 5927 , queue_length = 1
Next arrival time: 5946
Begin_service --> caseid = 98 , time = 5927 , queue_length = 1
Customer joins queue --> caseid = 99 , time = 5946 , queue_length = 1
Next arrival time: 5951
Begin_service --> caseid = 99 , time = 5946 , queue_length = 1
Customer joins queue --> caseid = 100 , time = 5951 , queue_length = 1
Next arrival time: 5960
Begin_service --> caseid = 100 , time = 5951 , queue_length = 1
Customer joins queue --> caseid = 101 , time = 5960 , queue_length = 1
Next arrival time: 5961
Customer joins queue --> caseid = 102 , time = 5961 , queue_length = 2
Next arrival time: 5967
Customer joins queue --> caseid = 103 , time = 5967 , queue_length = 3
Next arrival time: 6022
End_service --> caseid = 98 , time = 5987 , queue_length = 3
Customer 101 left the queue after waiting for 5627 minutes
Begin_service --> caseid = 102 , time = 5987 , queue_length = 2
Customer joins queue --> caseid = 104 , time = 6022 , queue_length = 2
Next arrival time: 6041
Customer joins queue --> caseid = 105 , time = 6041 , queue_length = 3
Next arrival time: 6110
End_service --> caseid = 100 , time = 6051 , queue_length = 3
Customer 103 left the queue after waiting for 5691 minutes
Begin_service --> caseid = 104 , time = 6051 , queue_length = 2
Customer joins queue --> caseid = 106 , time = 6110 , queue_length = 2
Next arrival time: 6162
End_service --> caseid = 102 , time = 6119 , queue_length = 2
Begin_service --> caseid = 105 , time = 6119 , queue_length = 2
Customer joins queue --> caseid = 107 , time = 6162 , queue_length = 2
Next arrival time: 6165
Customer joins queue --> caseid = 108 , time = 6165 , queue_length = 3
Next arrival time: 6200
End_service --> caseid = 105 , time = 6179 , queue_length = 3
Customer 106 left the queue after waiting for 5819 minutes
Begin_service --> caseid = 107 , time = 6179 , queue_length = 2
End_service --> caseid = 99 , time = 6186 , queue_length = 1
Begin_service --> caseid = 108 , time = 6186 , queue_length = 1
End_service --> caseid = 104 , time = 6197 , queue_length = 0
Customer joins queue --> caseid = 109 , time = 6200 , queue_length = 1
Next arrival time: 6230
Begin_service --> caseid = 109 , time = 6200 , queue_length = 1
Customer joins queue --> caseid = 110 , time = 6230 , queue_length = 1
Next arrival time: 6366
End_service --> caseid = 107 , time = 6239 , queue_length = 1
Customer 110 left the queue after waiting for 6119 minutes
End_service --> caseid = 108 , time = 6255 , queue_length = 0
End_service --> caseid = 109 , time = 6347 , queue_length = 0
Customer joins queue --> caseid = 111 , time = 6366 , queue_length = 1
Next arrival time: 6430
Begin_service --> caseid = 111 , time = 6366 , queue_length = 1
Customer joins queue --> caseid = 112 , time = 6430 , queue_length = 1
Next arrival time: 6435

Begin_service --> caseid = 112 , time = 6430 , queue_length = 1
Customer joins queue --> caseid = 113 , time = 6435 , queue_length = 1
Next arrival time: 6581
Customer 113 left the queue after waiting for 6315 minutes
End_service --> caseid = 111 , time = 6509 , queue_length = 0
Customer joins queue --> caseid = 114 , time = 6581 , queue_length = 1
Next arrival time: 6738
Begin_service --> caseid = 114 , time = 6581 , queue_length = 1
End_service --> caseid = 112 , time = 6642 , queue_length = 0
End_service --> caseid = 114 , time = 6715 , queue_length = 0
Customer joins queue --> caseid = 115 , time = 6738 , queue_length = 1
Next arrival time: 6785
Customer 115 left the queue after waiting for 6618 minutes
Customer joins queue --> caseid = 116 , time = 6785 , queue_length = 1
Next arrival time: 6968
Begin_service --> caseid = 116 , time = 6785 , queue_length = 1
End_service --> caseid = 116 , time = 6917 , queue_length = 0
Customer joins queue --> caseid = 117 , time = 6968 , queue_length = 1
Next arrival time: 7017
Begin_service --> caseid = 117 , time = 6968 , queue_length = 1
Customer joins queue --> caseid = 118 , time = 7017 , queue_length = 1
Next arrival time: 7040
Begin_service --> caseid = 118 , time = 7017 , queue_length = 1
End_service --> caseid = 117 , time = 7028 , queue_length = 0
Customer joins queue --> caseid = 119 , time = 7040 , queue_length = 1
Next arrival time: 7062
Begin_service --> caseid = 119 , time = 7040 , queue_length = 1
Customer joins queue --> caseid = 120 , time = 7062 , queue_length = 1
Next arrival time: 7251
Customer 120 left the queue after waiting for 6942 minutes
End_service --> caseid = 119 , time = 7230 , queue_length = 0
Customer joins queue --> caseid = 121 , time = 7251 , queue_length = 1
Next arrival time: 7357
Begin_service --> caseid = 121 , time = 7251 , queue_length = 1
End_service --> caseid = 118 , time = 7317 , queue_length = 0
Customer joins queue --> caseid = 122 , time = 7357 , queue_length = 1
Next arrival time: 7423
Begin_service --> caseid = 122 , time = 7357 , queue_length = 1
End_service --> caseid = 121 , time = 7419 , queue_length = 0
Customer joins queue --> caseid = 123 , time = 7423 , queue_length = 1
Next arrival time: 7458
Begin_service --> caseid = 123 , time = 7423 , queue_length = 1
Customer joins queue --> caseid = 124 , time = 7458 , queue_length = 1
Next arrival time: 7607
Begin_service --> caseid = 124 , time = 7458 , queue_length = 1
End_service --> caseid = 123 , time = 7485 , queue_length = 0
End_service --> caseid = 122 , time = 7487 , queue_length = 0
Customer joins queue --> caseid = 125 , time = 7607 , queue_length = 1
Next arrival time: 7820
Customer 125 left the queue after waiting for 7487 minutes
End_service --> caseid = 124 , time = 7631 , queue_length = 0
Customer joins queue --> caseid = 126 , time = 7820 , queue_length = 1
Next arrival time: 7841
Begin_service --> caseid = 126 , time = 7820 , queue_length = 1
Customer joins queue --> caseid = 127 , time = 7841 , queue_length = 1
Next arrival time: 8038
Begin_service --> caseid = 127 , time = 7841 , queue_length = 1
End_service --> caseid = 126 , time = 7890 , queue_length = 0
End_service --> caseid = 127 , time = 7901 , queue_length = 0
Customer joins queue --> caseid = 128 , time = 8038 , queue_length = 1

Next arrival time: 8201
Begin_service --> caseid = 128 , time = 8038 , queue_length = 1
End_service --> caseid = 128 , time = 8114 , queue_length = 0
Customer joins queue --> caseid = 129 , time = 8201 , queue_length = 1
Next arrival time: 8318
Customer 129 left the queue after waiting for 8081 minutes
Customer joins queue --> caseid = 130 , time = 8318 , queue_length = 1
Next arrival time: 8392
Begin_service --> caseid = 130 , time = 8318 , queue_length = 1
End_service --> caseid = 130 , time = 8378 , queue_length = 0
Customer joins queue --> caseid = 131 , time = 8392 , queue_length = 1
Next arrival time: 8444
Customer 131 left the queue after waiting for 8272 minutes
Customer joins queue --> caseid = 132 , time = 8444 , queue_length = 1
Next arrival time: 8471
Begin_service --> caseid = 132 , time = 8444 , queue_length = 1
Customer joins queue --> caseid = 133 , time = 8471 , queue_length = 1
Next arrival time: 8498
Customer 133 left the queue after waiting for 8351 minutes
Customer joins queue --> caseid = 134 , time = 8498 , queue_length = 1
Next arrival time: 8630
Begin_service --> caseid = 134 , time = 8498 , queue_length = 1
Customer joins queue --> caseid = 135 , time = 8630 , queue_length = 1
Next arrival time: 8697
Begin_service --> caseid = 135 , time = 8630 , queue_length = 1
End_service --> caseid = 132 , time = 8641 , queue_length = 0
End_service --> caseid = 135 , time = 8690 , queue_length = 0
End_service --> caseid = 134 , time = 8694 , queue_length = 0
Customer joins queue --> caseid = 136 , time = 8697 , queue_length = 1
Next arrival time: 8705
Begin_service --> caseid = 136 , time = 8697 , queue_length = 1
Customer joins queue --> caseid = 137 , time = 8705 , queue_length = 1
Next arrival time: 8731
Begin_service --> caseid = 137 , time = 8705 , queue_length = 1
Customer joins queue --> caseid = 138 , time = 8731 , queue_length = 1
Next arrival time: 8758
Begin_service --> caseid = 138 , time = 8731 , queue_length = 1
End_service --> caseid = 136 , time = 8757 , queue_length = 0
Customer joins queue --> caseid = 139 , time = 8758 , queue_length = 1
Next arrival time: 8815
Begin_service --> caseid = 139 , time = 8758 , queue_length = 1
End_service --> caseid = 138 , time = 8791 , queue_length = 0
Customer joins queue --> caseid = 140 , time = 8815 , queue_length = 1
Next arrival time: 8935
Begin_service --> caseid = 140 , time = 8815 , queue_length = 1
End_service --> caseid = 139 , time = 8818 , queue_length = 0
End_service --> caseid = 140 , time = 8875 , queue_length = 0
End_service --> caseid = 137 , time = 8909 , queue_length = 0
Customer joins queue --> caseid = 141 , time = 8935 , queue_length = 1
Next arrival time: 9057
Begin_service --> caseid = 141 , time = 8935 , queue_length = 1
End_service --> caseid = 141 , time = 9000 , queue_length = 0
Customer joins queue --> caseid = 142 , time = 9057 , queue_length = 1
Next arrival time: 9062
Begin_service --> caseid = 142 , time = 9057 , queue_length = 1
Customer joins queue --> caseid = 143 , time = 9062 , queue_length = 1
Next arrival time: 9170
Customer 143 left the queue after waiting for 8942 minutes
Customer joins queue --> caseid = 144 , time = 9170 , queue_length = 1
Next arrival time: 9185

Begin_service --> caseid = 144 , time = 9170 , queue_length = 1
Customer joins queue --> caseid = 145 , time = 9185 , queue_length = 1
Next arrival time: 9280
Begin_service --> caseid = 145 , time = 9185 , queue_length = 1
End_service --> caseid = 142 , time = 9199 , queue_length = 0
End_service --> caseid = 144 , time = 9237 , queue_length = 0
End_service --> caseid = 145 , time = 9245 , queue_length = 0
Customer joins queue --> caseid = 146 , time = 9280 , queue_length = 1
Next arrival time: 9382
Begin_service --> caseid = 146 , time = 9280 , queue_length = 1
Customer joins queue --> caseid = 147 , time = 9382 , queue_length = 1
Next arrival time: 9386
Customer 147 left the queue after waiting for 9262 minutes
Customer joins queue --> caseid = 148 , time = 9386 , queue_length = 1
Next arrival time: 9401
Begin_service --> caseid = 148 , time = 9386 , queue_length = 1
Customer joins queue --> caseid = 149 , time = 9401 , queue_length = 1
Next arrival time: 9497
Customer 149 left the queue after waiting for 9281 minutes
Customer joins queue --> caseid = 150 , time = 9497 , queue_length = 1
Next arrival time: 9499
Begin_service --> caseid = 150 , time = 9497 , queue_length = 1
Customer joins queue --> caseid = 151 , time = 9499 , queue_length = 1
Next arrival time: 9506
Customer joins queue --> caseid = 152 , time = 9506 , queue_length = 2
Next arrival time: 9722
End_service --> caseid = 148 , time = 9516 , queue_length = 2
Begin_service --> caseid = 151 , time = 9516 , queue_length = 2
End_service --> caseid = 146 , time = 9537 , queue_length = 1
Customer 152 left the queue after waiting for 9417 minutes
End_service --> caseid = 150 , time = 9557 , queue_length = 0
End_service --> caseid = 151 , time = 9576 , queue_length = 0
Customer joins queue --> caseid = 153 , time = 9722 , queue_length = 1
Next arrival time: 9789
Customer 153 left the queue after waiting for 9602 minutes
Customer joins queue --> caseid = 154 , time = 9789 , queue_length = 1
Next arrival time: 9838
Begin_service --> caseid = 154 , time = 9789 , queue_length = 1
Customer joins queue --> caseid = 155 , time = 9838 , queue_length = 1
Next arrival time: 9840
Begin_service --> caseid = 155 , time = 9838 , queue_length = 1
Customer joins queue --> caseid = 156 , time = 9840 , queue_length = 1
Next arrival time: 9846
Begin_service --> caseid = 156 , time = 9840 , queue_length = 1
Customer joins queue --> caseid = 157 , time = 9846 , queue_length = 1
Next arrival time: 9887
Customer joins queue --> caseid = 158 , time = 9887 , queue_length = 2
Next arrival time: 9928
End_service --> caseid = 155 , time = 9898 , queue_length = 2
Begin_service --> caseid = 157 , time = 9898 , queue_length = 2
Customer joins queue --> caseid = 159 , time = 9928 , queue_length = 2
Next arrival time: 10094
End_service --> caseid = 154 , time = 9939 , queue_length = 2
Customer 158 left the queue after waiting for 9699 minutes
Begin_service --> caseid = 159 , time = 9939 , queue_length = 1
End_service --> caseid = 157 , time = 9977 , queue_length = 0
End_service --> caseid = 159 , time = 9999 , queue_length = 0
Customer joins queue --> caseid = 160 , time = 10094 , queue_length = 1
Next arrival time: 10098
Begin_service --> caseid = 160 , time = 10094 , queue_length = 1

Customer joins queue --> caseid = 161 , time = 10098 , queue_length = 1
Next arrival time: 10178
Begin_service --> caseid = 161 , time = 10098 , queue_length = 1
End_service --> caseid = 156 , time = 10140 , queue_length = 0
Customer joins queue --> caseid = 162 , time = 10178 , queue_length = 1
Next arrival time: 10263
Begin_service --> caseid = 162 , time = 10178 , queue_length = 1
Customer joins queue --> caseid = 163 , time = 10263 , queue_length = 1
Next arrival time: 10302
End_service --> caseid = 162 , time = 10277 , queue_length = 1
Customer 163 left the queue after waiting for 10157 minutes
End_service --> caseid = 161 , time = 10297 , queue_length = 0
Customer joins queue --> caseid = 164 , time = 10302 , queue_length = 1
Next arrival time: 10369
Begin_service --> caseid = 164 , time = 10302 , queue_length = 1
End_service --> caseid = 164 , time = 10362 , queue_length = 0
Customer joins queue --> caseid = 165 , time = 10369 , queue_length = 1
Next arrival time: 10449
Begin_service --> caseid = 165 , time = 10369 , queue_length = 1
End_service --> caseid = 160 , time = 10394 , queue_length = 0
Customer joins queue --> caseid = 166 , time = 10449 , queue_length = 1
Next arrival time: 10663
Begin_service --> caseid = 166 , time = 10449 , queue_length = 1
End_service --> caseid = 165 , time = 10515 , queue_length = 0
End_service --> caseid = 166 , time = 10643 , queue_length = 0
Customer joins queue --> caseid = 167 , time = 10663 , queue_length = 1
Next arrival time: 10795
Customer 167 left the queue after waiting for 10543 minutes
Customer joins queue --> caseid = 168 , time = 10795 , queue_length = 1
Next arrival time: 10806
Begin_service --> caseid = 168 , time = 10795 , queue_length = 1
Customer joins queue --> caseid = 169 , time = 10806 , queue_length = 1
Next arrival time: 10816
Begin_service --> caseid = 169 , time = 10806 , queue_length = 1
Customer joins queue --> caseid = 170 , time = 10816 , queue_length = 1
Next arrival time: 10833
Customer 170 left the queue after waiting for 10696 minutes
Customer joins queue --> caseid = 171 , time = 10833 , queue_length = 1
Next arrival time: 10885
Begin_service --> caseid = 171 , time = 10833 , queue_length = 1
Customer joins queue --> caseid = 172 , time = 10885 , queue_length = 1
Next arrival time: 10914
End_service --> caseid = 171 , time = 10893 , queue_length = 1
Begin_service --> caseid = 172 , time = 10893 , queue_length = 1
Customer joins queue --> caseid = 173 , time = 10914 , queue_length = 1
Next arrival time: 11132
End_service --> caseid = 168 , time = 10923 , queue_length = 1
Begin_service --> caseid = 173 , time = 10923 , queue_length = 1
End_service --> caseid = 172 , time = 10953 , queue_length = 0
End_service --> caseid = 173 , time = 10983 , queue_length = 0
End_service --> caseid = 169 , time = 11063 , queue_length = 0
Customer joins queue --> caseid = 174 , time = 11132 , queue_length = 1
Next arrival time: 11159
Begin_service --> caseid = 174 , time = 11132 , queue_length = 1
Customer joins queue --> caseid = 175 , time = 11159 , queue_length = 1
Next arrival time: 11167
Begin_service --> caseid = 175 , time = 11159 , queue_length = 1
Customer joins queue --> caseid = 176 , time = 11167 , queue_length = 1
Next arrival time: 11206
Begin_service --> caseid = 176 , time = 11167 , queue_length = 1

Customer joins queue --> caseid = 177 , time = 11206 , queue_length = 1
Next arrival time: 11317
End_service --> caseid = 174 , time = 11223 , queue_length = 1
Begin_service --> caseid = 177 , time = 11223 , queue_length = 1
End_service --> caseid = 175 , time = 11235 , queue_length = 0
End_service --> caseid = 176 , time = 11251 , queue_length = 0
End_service --> caseid = 177 , time = 11283 , queue_length = 0
Customer joins queue --> caseid = 178 , time = 11317 , queue_length = 1
Next arrival time: 11328
Begin_service --> caseid = 178 , time = 11317 , queue_length = 1
Customer joins queue --> caseid = 179 , time = 11328 , queue_length = 1
Next arrival time: 11344
Begin_service --> caseid = 179 , time = 11328 , queue_length = 1
Customer joins queue --> caseid = 180 , time = 11344 , queue_length = 1
Next arrival time: 11463
Begin_service --> caseid = 180 , time = 11344 , queue_length = 1
Customer joins queue --> caseid = 181 , time = 11463 , queue_length = 1
Next arrival time: 11559
End_service --> caseid = 178 , time = 11525 , queue_length = 1
Customer 181 left the queue after waiting for 11405 minutes
End_service --> caseid = 180 , time = 11545 , queue_length = 0
Customer joins queue --> caseid = 182 , time = 11559 , queue_length = 1
Next arrival time: 11660
Begin_service --> caseid = 182 , time = 11559 , queue_length = 1
End_service --> caseid = 179 , time = 11628 , queue_length = 0
End_service --> caseid = 182 , time = 11642 , queue_length = 0
Customer joins queue --> caseid = 183 , time = 11660 , queue_length = 1
Next arrival time: 11670
Customer 183 left the queue after waiting for 11540 minutes
Customer joins queue --> caseid = 184 , time = 11670 , queue_length = 1
Next arrival time: 11681
Begin_service --> caseid = 184 , time = 11670 , queue_length = 1
Customer joins queue --> caseid = 185 , time = 11681 , queue_length = 1
Next arrival time: 11768
Begin_service --> caseid = 185 , time = 11681 , queue_length = 1
End_service --> caseid = 184 , time = 11730 , queue_length = 0
End_service --> caseid = 185 , time = 11741 , queue_length = 0
Customer joins queue --> caseid = 186 , time = 11768 , queue_length = 1
Next arrival time: 11877
Begin_service --> caseid = 186 , time = 11768 , queue_length = 1
End_service --> caseid = 186 , time = 11828 , queue_length = 0
Customer joins queue --> caseid = 187 , time = 11877 , queue_length = 1
Next arrival time: 11886
Begin_service --> caseid = 187 , time = 11877 , queue_length = 1
Customer joins queue --> caseid = 188 , time = 11886 , queue_length = 1
Next arrival time: 11906
Begin_service --> caseid = 188 , time = 11886 , queue_length = 1
Customer joins queue --> caseid = 189 , time = 11906 , queue_length = 1
Next arrival time: 11974
Begin_service --> caseid = 189 , time = 11906 , queue_length = 1
End_service --> caseid = 187 , time = 11937 , queue_length = 0
Customer joins queue --> caseid = 190 , time = 11974 , queue_length = 1
Next arrival time: 11987
Begin_service --> caseid = 190 , time = 11974 , queue_length = 1
End_service --> caseid = 189 , time = 11980 , queue_length = 0
Customer joins queue --> caseid = 191 , time = 11987 , queue_length = 1
Next arrival time: 12001
Begin_service --> caseid = 191 , time = 11987 , queue_length = 1
Customer joins queue --> caseid = 192 , time = 12001 , queue_length = 1
Next arrival time: 12044

End_service --> caseid = 190 , time = 12034 , queue_length = 1
Customer 192 left the queue after waiting for 11914 minutes
Customer joins queue --> caseid = 193 , time = 12044 , queue_length = 1
Next arrival time: 12052
Begin_service --> caseid = 193 , time = 12044 , queue_length = 1
End_service --> caseid = 191 , time = 12047 , queue_length = 0
Customer joins queue --> caseid = 194 , time = 12052 , queue_length = 1
Next arrival time: 12120
Begin_service --> caseid = 194 , time = 12052 , queue_length = 1
End_service --> caseid = 188 , time = 12058 , queue_length = 0
End_service --> caseid = 193 , time = 12104 , queue_length = 0
End_service --> caseid = 194 , time = 12112 , queue_length = 0
Customer joins queue --> caseid = 195 , time = 12120 , queue_length = 1
Next arrival time: 12191
Begin_service --> caseid = 195 , time = 12120 , queue_length = 1
Customer joins queue --> caseid = 196 , time = 12191 , queue_length = 1
Next arrival time: 12207
Customer 196 left the queue after waiting for 12071 minutes
Customer joins queue --> caseid = 197 , time = 12207 , queue_length = 1
Next arrival time: 12362
Begin_service --> caseid = 197 , time = 12207 , queue_length = 1
End_service --> caseid = 195 , time = 12340 , queue_length = 0
Customer joins queue --> caseid = 198 , time = 12362 , queue_length = 1
Next arrival time: 12503
Customer 198 left the queue after waiting for 12242 minutes
Customer joins queue --> caseid = 199 , time = 12503 , queue_length = 1
Next arrival time: 12588
Customer 199 left the queue after waiting for 12383 minutes
End_service --> caseid = 197 , time = 12507 , queue_length = 0
Customer joins queue --> caseid = 200 , time = 12588 , queue_length = 1
Next arrival time: 12611
Begin_service --> caseid = 200 , time = 12588 , queue_length = 1
Customer joins queue --> caseid = 201 , time = 12611 , queue_length = 1
Next arrival time: 12650
Begin_service --> caseid = 201 , time = 12611 , queue_length = 1
Customer joins queue --> caseid = 202 , time = 12650 , queue_length = 1
Next arrival time: 12703
Begin_service --> caseid = 202 , time = 12650 , queue_length = 1
End_service --> caseid = 200 , time = 12667 , queue_length = 0
Customer joins queue --> caseid = 203 , time = 12703 , queue_length = 1
Next arrival time: 12729
Customer 203 left the queue after waiting for 12583 minutes
End_service --> caseid = 201 , time = 12714 , queue_length = 0
Customer joins queue --> caseid = 204 , time = 12729 , queue_length = 1
Next arrival time: 12748
Begin_service --> caseid = 204 , time = 12729 , queue_length = 1
Customer joins queue --> caseid = 205 , time = 12748 , queue_length = 1
Next arrival time: 12824
Begin_service --> caseid = 205 , time = 12748 , queue_length = 1
Customer joins queue --> caseid = 206 , time = 12824 , queue_length = 1
Next arrival time: 12831
Customer joins queue --> caseid = 207 , time = 12831 , queue_length = 2
Next arrival time: 12891
End_service --> caseid = 204 , time = 12875 , queue_length = 2
Begin_service --> caseid = 206 , time = 12875 , queue_length = 2
Customer joins queue --> caseid = 208 , time = 12891 , queue_length = 2
Next arrival time: 12938
Customer joins queue --> caseid = 209 , time = 12938 , queue_length = 3
Next arrival time: 13147
End_service --> caseid = 202 , time = 12950 , queue_length = 3

Begin_service --> caseid = 207 , time = 12950 , queue_length = 3
End_service --> caseid = 205 , time = 13048 , queue_length = 2
Begin_service --> caseid = 208 , time = 13048 , queue_length = 2
End_service --> caseid = 208 , time = 13108 , queue_length = 1
Begin_service --> caseid = 209 , time = 13108 , queue_length = 1
End_service --> caseid = 207 , time = 13139 , queue_length = 0
Customer joins queue --> caseid = 210 , time = 13147 , queue_length = 1
Next arrival time: 13194
Customer 210 left the queue after waiting for 13027 minutes
End_service --> caseid = 206 , time = 13175 , queue_length = 0
Customer joins queue --> caseid = 211 , time = 13194 , queue_length = 1
Next arrival time: 13244
Begin_service --> caseid = 211 , time = 13194 , queue_length = 1
Customer joins queue --> caseid = 212 , time = 13244 , queue_length = 1
Next arrival time: 13244
Begin_service --> caseid = 212 , time = 13244 , queue_length = 1
Customer joins queue --> caseid = 213 , time = 13244 , queue_length = 1
Next arrival time: 13283
Customer joins queue --> caseid = 214 , time = 13283 , queue_length = 2
Next arrival time: 13373
End_service --> caseid = 209 , time = 13288 , queue_length = 2
Customer 213 left the queue after waiting for 13048 minutes
Customer 214 left the queue after waiting for 13168 minutes
End_service --> caseid = 212 , time = 13338 , queue_length = 0
Customer joins queue --> caseid = 215 , time = 13373 , queue_length = 1
Next arrival time: 13550
Begin_service --> caseid = 215 , time = 13373 , queue_length = 1
End_service --> caseid = 211 , time = 13428 , queue_length = 0
Customer joins queue --> caseid = 216 , time = 13550 , queue_length = 1
Next arrival time: 13613
Begin_service --> caseid = 216 , time = 13550 , queue_length = 1
End_service --> caseid = 215 , time = 13566 , queue_length = 0
Customer joins queue --> caseid = 217 , time = 13613 , queue_length = 1
Next arrival time: 13752
Customer 217 left the queue after waiting for 13493 minutes
End_service --> caseid = 216 , time = 13635 , queue_length = 0
Customer joins queue --> caseid = 218 , time = 13752 , queue_length = 1
Next arrival time: 13853
Customer 218 left the queue after waiting for 13632 minutes
Customer joins queue --> caseid = 219 , time = 13853 , queue_length = 1
Next arrival time: 13932
Begin_service --> caseid = 219 , time = 13853 , queue_length = 1
End_service --> caseid = 219 , time = 13913 , queue_length = 0
Customer joins queue --> caseid = 220 , time = 13932 , queue_length = 1
Next arrival time: 13937
Begin_service --> caseid = 220 , time = 13932 , queue_length = 1
Customer joins queue --> caseid = 221 , time = 13937 , queue_length = 1
Next arrival time: 14184
Begin_service --> caseid = 221 , time = 13937 , queue_length = 1
End_service --> caseid = 220 , time = 13992 , queue_length = 0
End_service --> caseid = 221 , time = 13997 , queue_length = 0
Customer joins queue --> caseid = 222 , time = 14184 , queue_length = 1
Next arrival time: 14212
Begin_service --> caseid = 222 , time = 14184 , queue_length = 1
Customer joins queue --> caseid = 223 , time = 14212 , queue_length = 1
Next arrival time: 14236
Begin_service --> caseid = 223 , time = 14212 , queue_length = 1
Customer joins queue --> caseid = 224 , time = 14236 , queue_length = 1
Next arrival time: 14240
Begin_service --> caseid = 224 , time = 14236 , queue_length = 1

```

Customer joins queue --> caseid = 225 , time = 14240 , queue_length = 1
Next arrival time: 14273
Customer joins queue --> caseid = 226 , time = 14273 , queue_length = 2
Next arrival time: 14294
End_service --> caseid = 223 , time = 14280 , queue_length = 2
Begin_service --> caseid = 225 , time = 14280 , queue_length = 2
Customer joins queue --> caseid = 227 , time = 14294 , queue_length = 2
Next arrival time: 14349
End_service --> caseid = 225 , time = 14340 , queue_length = 2
Begin_service --> caseid = 226 , time = 14340 , queue_length = 2
Customer joins queue --> caseid = 228 , time = 14349 , queue_length = 2
Next arrival time: 14368
End_service --> caseid = 224 , time = 14360 , queue_length = 2
Begin_service --> caseid = 227 , time = 14360 , queue_length = 2
Customer joins queue --> caseid = 229 , time = 14368 , queue_length = 2
Next arrival time: 14397
End_service --> caseid = 222 , time = 14387 , queue_length = 2
Begin_service --> caseid = 228 , time = 14387 , queue_length = 2
Customer joins queue --> caseid = 230 , time = 14397 , queue_length = 2
Next arrival time: 14533

```

```

In [79]: #create text file for simulation output
simulation_trace_file_name = 'simulation-program-trace-' + simulation_file_iden
with open(simulation_trace_file_name, 'wt') as ftrace:
    for d in simulation_data:
        print(str(d), file = ftrace)
print()
print('simulation program trace written to file:',simulation_trace_file_name)

# convert list of tuples to list of lists
event_log_list = [list(element) for element in event_log]

# convert to pandas data frame
caseid_list = []
time_list = []
activity_list = []
for d in event_log_list:
    if d[0] > 0:
        caseid_list.append(d[0])
        time_list.append(d[1])
        activity_list.append(d[2])
event_log_df = pd.DataFrame({'caseid':caseid_list,
                             'time':time_list,
                             'activity':activity_list})

#save event log to CSV file
event_log_file_name = 'simulation-event-log-' + simulation_file_identifier + '
event_log_df.to_csv(event_log_file_name, index = False)
print()
print('event log written to file:',event_log_file_name)

simulation program trace written to file: simulation-program-trace-4-hours-3-1
-2-5-1-10-10.txt

event log written to file: simulation-event-log-4-hours-3-1-2-5-1-10-10.csv

```

```

In [80]: event_log_df.head()

```

Out[80]:

	caseid	time	activity
0	1	11	arrival
1	1	11	join_queue
2	1	11	begin_service
3	2	69	arrival
4	2	69	join_queue

In [81]:

```
avg_ticket = 10
sim_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='end_serv
lost_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='balk'])
barista_wages = 18 #per hour
sim_payroll = baristas * barista_wages* sim_hours

#print simulation results
print()
print('Simulation parameter settings:')
print(baristas, 'baristas/servers')
print(' Service time settings (in minutes)')
print('     minimum:',min_service_time)
print('     mean:     ',mean_service_time)
print('     maximum:',max_service_time)
print()
print('Customers set to arrive every', mean_inter_arrival_time, 'minute(s) on a
print('Customers will not join the queue/waiting line if it has',balk_queue_len
print('Customers will leave the queue/waiting line after waiting', max_wait_tim
print('The simulation is set to run for ', sim_hours,' hours (',60 * sim_hours
print()
end_time = np.max(event_log_df["time"])
print('Results after ',end_time, ' seconds (', round(end_time/60, 2), ' minutes
caseid_list = pd.unique(event_log_df['caseid'])
print(len(caseid_list), 'unique customers arrived')
print(len(event_log_df['activity'])[event_log_df['activity']=='join_queue']), 'cu
print(len(event_log_df['activity'])[event_log_df['activity']=='balk']), 'custome
print(len(event_log_df['activity'])[event_log_df['activity']=='renege']), 'custor
print(len(event_log_df['activity'])[event_log_df['activity']=='begin_service']),
print(len(event_log_df['activity'])[event_log_df['activity']=='end_service']), 'c
print(caseid_queue.qsize()), 'customers were still in line at the end of the sim
print()
print(f'${sim_revenue:.2f} average simulation revenue (assuming ${avg_ticket} a
print(f'${lost_revenue:.2f} average lost revenue (balking & renegeing)')
print(f'${sim_payroll:.2f} simulation payroll costs')

# case-by-case logs are very useful for checking the logic of the simulation
case_by_case_event_file_name = 'simulation-program-case-by-case-events-' + sim
with open(case_by_case_event_file_name, 'wt') as fcasedata:
    lastcase_arrival_time = 0 # initialize for use with first case
    # create lists for storing time interval data
    inter_arrival_times = [] # computed across cases
    waiting_time = [] # computed within each case that has begun service
    service_time = [] # computed within each case that has ended service
    for thiscase in caseid_list:
        # select subset of rows for thiscase and use as a Pandas data frame
        thiscase_events = event_log_df[['caseid','time','activity']][event_log
        print(file = fcasedata)
        print('events for caseid',thiscase, file = fcasedata)
```



```

print(thiscase_events, file = fcasedata)
# compute inter-arrival times between cases
thiscase_arrival_time = thiscase_events.loc[thiscase_events['activity']]
inter_arrival_time = thiscase_arrival_time - lastcase_arrival_time
inter_arrival_times.append(inter_arrival_time)
print(file = fcasedata)
print('time between arrivals (this case minus previous case):', inter_a
lastcase_arrival_time = thiscase_arrival_time # save for next case in
# compute waiting times within this case (must have begin_service event)
if thiscase_events.loc[thiscase_events['activity']=='begin_service'].shap
    thiscase_begin_service = thiscase_events.loc[thiscase_events['activi
    thiscase_join_queue = thiscase_arrival_time = thiscase_events.loc[
    thiscase_waiting_time = thiscase_begin_service - thiscase_join_que
    waiting_time.append(thiscase_waiting_time)
    print('waiting time for this case (time between joining queue and l
# compute service time within this case (must have end_service event/ac
if thiscase_events.loc[thiscase_events['activity']=='end_service'].shap
    thiscase_end_service = thiscase_events.loc[thiscase_events['activi
    thiscase_service_time = thiscase_end_service - thiscase_begin_serv
    service_time.append(thiscase_service_time)
    print('service time for this case (time between beginning and endin

print()
print('Summary statistics for customer inter-arrival times:')
print(' Minimum: ', round(np.min(inter_arrival_times),2), ' seconds (', round(n
print(' Mean:      ', round(np.average(inter_arrival_times),2), ' seconds (', ro
print(' Maximum: ', round(np.max(inter_arrival_times),2), ' seconds (', round(n
print()
print('Summary statistics for customer wait times:')
print(' Minimum: ', round(np.min(waiting_time),2), ' seconds (', round(np.min(v
print(' Mean:      ', round(np.average(waiting_time),2), ' seconds (', round(np.a
print(' Maximum: ', round(np.max(waiting_time),2), ' seconds (', round(np.max(v
print()
print('Summary statistics for service times:')
print(' Minimum: ', round(np.min(service_time),2), ' seconds (', round(np.min(s
print(' Mean:      ', round(np.average(service_time),2), ' seconds (', round(np.a
print(' Maximum: ', round(np.max(service_time),2), ' seconds (', round(np.max(s

```

Simulation parameter settings:

3 baristas/servers

Service time settings (in minutes)

minimum: 1

mean: 2

maximum: 5

Customers set to arrive every 1 minute(s) on average

Customers will not join the queue/waiting line if it has 10 customers in it (balking)

Customers will leave the queue/waiting line after waiting 10 minute(s) (reneging)

The simulation is set to run for 4 hours (240 minutes)

Results after 14397 seconds (239.95 minutes, 4.0 hours):

230 unique customers arrived

230 customers joined the queue for service

0 customers balked (lost business)

54 customers reneged (left queue, lost business)

174 customers began service

171 customers ended service

2 customers were still in line at the end of the simulation

\$1710.00 average simulation revenue (assuming \$10 average ticket)

\$540.00 average lost revenue (balking & reneging)

\$216.00 simulation payroll costs

Summary statistics for customer inter-arrival times:

Minimum: 0 seconds (0.0 minutes)

Mean: 62.6 seconds (1.04 minutes)

Maximum: 476 seconds (7.93 minutes)

Summary statistics for customer wait times:

Minimum: 0 seconds (0.0 minutes)

Mean: 20.91 seconds (0.35 minutes)

Maximum: 198 seconds (3.3 minutes)

Summary statistics for service times:

Minimum: 60 seconds (1.0 minutes)

Mean: 131.43 seconds (2.19 minutes)

Maximum: 300 seconds (5.0 minutes)

Afternoon Shift Simulation 10 A.M. - 2 P.M.

Define Staffing, Wait, Balking, Reneging

```
In [82]: #define staff
baristas = 2

#define service times (in minutes)
min_service_time = 1
mean_service_time = 2
max_service_time = 5

#define wait times (in minutes)
max_wait_time = 6
```

```

#define arrival pace (in minutes)
mean_inter_arrival_time = 5

#define balking tolerance (number of people in line)
balk_queue_length = 6

```

```

In [83]: #enable reproducible results
obtain_reproducible_results = True

#set simulation parameters
sim_hours = 4
fixed_sim_time = sim_hours * 60 * 60 #convert hours to seconds

#create parameter strings
parameter_strings_list = [str(sim_hours), 'hours',
                           str(baristas), str(min_service_time),
                           str(mean_service_time), str(max_service_time),
                           str(mean_inter_arrival_time), str(balk_queue_length),
                           separator = '_']
simulation_file_identififier = separator.join(parameter_strings_list)

```

```

In [84]: #set random seed
if obtain_reproducible_results:
    np.random.seed(9876)

#set simulation trace monitoring
simulation_data = []
this_trace_monitor = partial(trace_monitor, simulation_data)

env = simpy.Environment()
trace(env, this_trace_monitor)

env.process(test_process(env))

#set FIFO queue for caseid values
caseid_queue = queue.Queue()

#set limits on baristas resource
baristas_on_shift = simpy.Resource(env, capacity = baristas)
caseid = -1

#create event log tuple
event_log = [(caseid, 0, 'null_start_simulation')]
env.process(event_log_append(env, caseid, env.now, 'start_simulation', event_log))

#call customer arrival generator to start simulation
env.process(arrival(env, caseid, caseid_queue, event_log))

env.run(until = fixed_sim_time)

```

Out[84]: <Process(test_process) object at 0x7feb890f3e50>

Out[84]: <Process(event_log_append) object at 0x7feb890f3e20>

Out[84]: <Process(arrival) object at 0x7feb869ed8b0>

Next arrival time: 54
Customer joins queue --> caseid = 1 , time = 54 , queue_length = 1
Next arrival time: 345
Begin_service --> caseid = 1 , time = 54 , queue_length = 1
End_service --> caseid = 1 , time = 332 , queue_length = 0
Customer joins queue --> caseid = 2 , time = 345 , queue_length = 1
Next arrival time: 781
Begin_service --> caseid = 2 , time = 345 , queue_length = 1
End_service --> caseid = 2 , time = 431 , queue_length = 0
Customer joins queue --> caseid = 3 , time = 781 , queue_length = 1
Next arrival time: 811
Customer 3 left the queue after waiting for 661 minutes
Customer joins queue --> caseid = 4 , time = 811 , queue_length = 1
Next arrival time: 996
Customer 4 left the queue after waiting for 691 minutes
Customer joins queue --> caseid = 5 , time = 996 , queue_length = 1
Next arrival time: 1040
Begin_service --> caseid = 5 , time = 996 , queue_length = 1
Customer joins queue --> caseid = 6 , time = 1040 , queue_length = 1
Next arrival time: 1243
Begin_service --> caseid = 6 , time = 1040 , queue_length = 1
End_service --> caseid = 6 , time = 1100 , queue_length = 0
Customer joins queue --> caseid = 7 , time = 1243 , queue_length = 1
Next arrival time: 1291
Begin_service --> caseid = 7 , time = 1243 , queue_length = 1
Customer joins queue --> caseid = 8 , time = 1291 , queue_length = 1
Next arrival time: 1396
End_service --> caseid = 5 , time = 1296 , queue_length = 1
Begin_service --> caseid = 8 , time = 1296 , queue_length = 1
End_service --> caseid = 7 , time = 1303 , queue_length = 0
End_service --> caseid = 8 , time = 1356 , queue_length = 0
Customer joins queue --> caseid = 9 , time = 1396 , queue_length = 1
Next arrival time: 1913
Begin_service --> caseid = 9 , time = 1396 , queue_length = 1
End_service --> caseid = 9 , time = 1550 , queue_length = 0
Customer joins queue --> caseid = 10 , time = 1913 , queue_length = 1
Next arrival time: 2263
Customer 10 left the queue after waiting for 1793 minutes
Customer joins queue --> caseid = 11 , time = 2263 , queue_length = 1
Next arrival time: 2878
Begin_service --> caseid = 11 , time = 2263 , queue_length = 1
End_service --> caseid = 11 , time = 2441 , queue_length = 0
Customer joins queue --> caseid = 12 , time = 2878 , queue_length = 1
Next arrival time: 3309
Customer 12 left the queue after waiting for 2758 minutes
Customer joins queue --> caseid = 13 , time = 3309 , queue_length = 1
Next arrival time: 3327
Begin_service --> caseid = 13 , time = 3309 , queue_length = 1
Customer joins queue --> caseid = 14 , time = 3327 , queue_length = 1
Next arrival time: 4050
Begin_service --> caseid = 14 , time = 3327 , queue_length = 1
End_service --> caseid = 13 , time = 3383 , queue_length = 0
End_service --> caseid = 14 , time = 3533 , queue_length = 0
Customer joins queue --> caseid = 15 , time = 4050 , queue_length = 1
Next arrival time: 4383
Begin_service --> caseid = 15 , time = 4050 , queue_length = 1
End_service --> caseid = 15 , time = 4141 , queue_length = 0
Customer joins queue --> caseid = 16 , time = 4383 , queue_length = 1
Next arrival time: 4724
Begin_service --> caseid = 16 , time = 4383 , queue_length = 1

End_service --> caseid = 16 , time = 4481 , queue_length = 0
Customer joins queue --> caseid = 17 , time = 4724 , queue_length = 1
Next arrival time: 5511
Begin_service --> caseid = 17 , time = 4724 , queue_length = 1
End_service --> caseid = 17 , time = 4841 , queue_length = 0
Customer joins queue --> caseid = 18 , time = 5511 , queue_length = 1
Next arrival time: 5568
Begin_service --> caseid = 18 , time = 5511 , queue_length = 1
Customer joins queue --> caseid = 19 , time = 5568 , queue_length = 1
Next arrival time: 6187
Begin_service --> caseid = 19 , time = 5568 , queue_length = 1
End_service --> caseid = 19 , time = 5628 , queue_length = 0
End_service --> caseid = 18 , time = 5763 , queue_length = 0
Customer joins queue --> caseid = 20 , time = 6187 , queue_length = 1
Next arrival time: 6479
Customer 20 left the queue after waiting for 6067 minutes
Customer joins queue --> caseid = 21 , time = 6479 , queue_length = 1
Next arrival time: 6874
Begin_service --> caseid = 21 , time = 6479 , queue_length = 1
End_service --> caseid = 21 , time = 6613 , queue_length = 0
Customer joins queue --> caseid = 22 , time = 6874 , queue_length = 1
Next arrival time: 6976
Customer 22 left the queue after waiting for 6754 minutes
Customer joins queue --> caseid = 23 , time = 6976 , queue_length = 1
Next arrival time: 7471
Begin_service --> caseid = 23 , time = 6976 , queue_length = 1
End_service --> caseid = 23 , time = 7142 , queue_length = 0
Customer joins queue --> caseid = 24 , time = 7471 , queue_length = 1
Next arrival time: 7561
Begin_service --> caseid = 24 , time = 7471 , queue_length = 1
Customer joins queue --> caseid = 25 , time = 7561 , queue_length = 1
Next arrival time: 7732
Customer 25 left the queue after waiting for 7441 minutes
Customer joins queue --> caseid = 26 , time = 7732 , queue_length = 1
Next arrival time: 7926
Customer 26 left the queue after waiting for 7612 minutes
End_service --> caseid = 24 , time = 7771 , queue_length = 0
Customer joins queue --> caseid = 27 , time = 7926 , queue_length = 1
Next arrival time: 8268
Begin_service --> caseid = 27 , time = 7926 , queue_length = 1
End_service --> caseid = 27 , time = 8072 , queue_length = 0
Customer joins queue --> caseid = 28 , time = 8268 , queue_length = 1
Next arrival time: 8782
Begin_service --> caseid = 28 , time = 8268 , queue_length = 1
End_service --> caseid = 28 , time = 8328 , queue_length = 0
Customer joins queue --> caseid = 29 , time = 8782 , queue_length = 1
Next arrival time: 8810
Begin_service --> caseid = 29 , time = 8782 , queue_length = 1
Customer joins queue --> caseid = 30 , time = 8810 , queue_length = 1
Next arrival time: 9093
Begin_service --> caseid = 30 , time = 8810 , queue_length = 1
End_service --> caseid = 30 , time = 8973 , queue_length = 0
End_service --> caseid = 29 , time = 9082 , queue_length = 0
Customer joins queue --> caseid = 31 , time = 9093 , queue_length = 1
Next arrival time: 9350
Begin_service --> caseid = 31 , time = 9093 , queue_length = 1
End_service --> caseid = 31 , time = 9153 , queue_length = 0
Customer joins queue --> caseid = 32 , time = 9350 , queue_length = 1
Next arrival time: 10179
Begin_service --> caseid = 32 , time = 9350 , queue_length = 1

```

End_service --> caseid = 32 , time = 9410 , queue_length = 0
Customer joins queue --> caseid = 33 , time = 10179 , queue_length = 1
Next arrival time: 10512
Begin_service --> caseid = 33 , time = 10179 , queue_length = 1
End_service --> caseid = 33 , time = 10239 , queue_length = 0
Customer joins queue --> caseid = 34 , time = 10512 , queue_length = 1
Next arrival time: 10702
Begin_service --> caseid = 34 , time = 10512 , queue_length = 1
Customer joins queue --> caseid = 35 , time = 10702 , queue_length = 1
Next arrival time: 10823
Begin_service --> caseid = 35 , time = 10702 , queue_length = 1
End_service --> caseid = 34 , time = 10719 , queue_length = 0
End_service --> caseid = 35 , time = 10762 , queue_length = 0
Customer joins queue --> caseid = 36 , time = 10823 , queue_length = 1
Next arrival time: 11001
Begin_service --> caseid = 36 , time = 10823 , queue_length = 1
End_service --> caseid = 36 , time = 10905 , queue_length = 0
Customer joins queue --> caseid = 37 , time = 11001 , queue_length = 1
Next arrival time: 11232
Begin_service --> caseid = 37 , time = 11001 , queue_length = 1
End_service --> caseid = 37 , time = 11092 , queue_length = 0
Customer joins queue --> caseid = 38 , time = 11232 , queue_length = 1
Next arrival time: 11858
Begin_service --> caseid = 38 , time = 11232 , queue_length = 1
End_service --> caseid = 38 , time = 11292 , queue_length = 0
Customer joins queue --> caseid = 39 , time = 11858 , queue_length = 1
Next arrival time: 13028
Begin_service --> caseid = 39 , time = 11858 , queue_length = 1
End_service --> caseid = 39 , time = 12080 , queue_length = 0
Customer joins queue --> caseid = 40 , time = 13028 , queue_length = 1
Next arrival time: 13162
Begin_service --> caseid = 40 , time = 13028 , queue_length = 1
End_service --> caseid = 40 , time = 13088 , queue_length = 0
Customer joins queue --> caseid = 41 , time = 13162 , queue_length = 1
Next arrival time: 13301
Customer 41 left the queue after waiting for 13042 minutes
Customer joins queue --> caseid = 42 , time = 13301 , queue_length = 1
Next arrival time: 13321
Customer 42 left the queue after waiting for 13181 minutes
Customer joins queue --> caseid = 43 , time = 13321 , queue_length = 1
Next arrival time: 14061
Begin_service --> caseid = 43 , time = 13321 , queue_length = 1
End_service --> caseid = 43 , time = 13381 , queue_length = 0
Customer joins queue --> caseid = 44 , time = 14061 , queue_length = 1
Next arrival time: 14275
Customer 44 left the queue after waiting for 13941 minutes
Customer joins queue --> caseid = 45 , time = 14275 , queue_length = 1
Next arrival time: 14471
Begin_service --> caseid = 45 , time = 14275 , queue_length = 1
End_service --> caseid = 45 , time = 14335 , queue_length = 0

```

```

In [85]: #create text file for simulation output
simulation_trace_file_name = 'simulation-program-trace-' + simulation_file_id
with open(simulation_trace_file_name, 'wt') as ftrace:
    for d in simulation_data:
        print(str(d), file = ftrace)
print()
print('simulation program trace written to file:',simulation_trace_file_name)

# convert list of tuples to list of lists

```

```

event_log_list = [list(element) for element in event_log]

# convert to pandas data frame
caseid_list = []
time_list = []
activity_list = []
for d in event_log_list:
    if d[0] > 0:
        caseid_list.append(d[0])
        time_list.append(d[1])
        activity_list.append(d[2])
event_log_df = pd.DataFrame({'caseid':caseid_list,
                             'time':time_list,
                             'activity':activity_list})

#save event log to CSV file
event_log_file_name = 'simulation-event-log-' + simulation_file_identifier + '
event_log_df.to_csv(event_log_file_name, index = False)
print()
print('event log written to file:',event_log_file_name)

```

simulation program trace written to file: simulation-program-trace-4-hours-2-1-2-5-5-6-6.txt

event log written to file: simulation-event-log-4-hours-2-1-2-5-5-6-6.csv

In [86]: event_log_df.head()

Out[86]:

	caseid	time	activity
0	1	54	arrival
1	1	54	join_queue
2	1	54	begin_service
3	1	332	end_service
4	2	345	arrival

In [87]:

```

avg_ticket = 5
sim_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='end_serv
lost_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='balk'])
barista_wages = 18 #per hour
sim_payroll = baristas * barista_wages* sim_hours

#print simulation results
print()
print('Simulation parameter settings:')
print(baristas, 'baristas/servers')
print(' Service time settings (in minutes)')
print(' minimum:',min_service_time)
print(' mean: ',mean_service_time)
print(' maximum:',max_service_time)
print()
print('Customers set to arrive every', mean_inter_arrival_time, 'minute(s) on a
print('Customers will not join the queue/waiting line if it has',balk_queue_len
print('Customers will leave the queue/waiting line after waiting', max_wait_tim
print('The simulation is set to run for ', sim_hours,' hours (',60 * sim_hours
print()
end_time = np.max(event_log_df["time"])

```

```

print('Results after ',end_time, ' seconds (', round(end_time/60, 2), ' minutes)
caseid_list = pd.unique(event_log_df['caseid'])
print(len(caseid_list), 'unique customers arrived')
print(len(event_log_df['activity'][event_log_df['activity']=='join_queue']), 'customers joined queue'
print(len(event_log_df['activity'][event_log_df['activity']=='balk']), 'customers bailed'
print(len(event_log_df['activity'][event_log_df['activity']=='renege']), 'customers reneged'
print(len(event_log_df['activity'][event_log_df['activity']=='begin_service']), 'customers began service'
print(len(event_log_df['activity'][event_log_df['activity']=='end_service']), 'customers ended service'
print(caseid_queue.qsize(), 'customers were still in line at the end of the simulation')
print()
print(f'${sim_revenue:.2f} average simulation revenue (assuming ${avg_ticket} average ticket)')
print(f'${lost_revenue:.2f} average lost revenue (balking & reneging)')
print(f'${sim_payroll:.2f} simulation payroll costs')

# case-by-case logs are very useful for checking the logic of the simulation
case_by_case_event_file_name = 'simulation-program-case-by-case-events-' + sim_id + '.txt'
with open(case_by_case_event_file_name, 'wt') as fcasedata:
    lastcase_arrival_time = 0 # initialize for use with first case
    # create lists for storing time interval data
    inter_arrival_times = [] # computed across cases
    waiting_time = [] # computed within each case that has begun service
    service_time = [] # computed within each case that has ended service
    for thiscase in caseid_list:
        # select subset of rows for thiscase and use as a Pandas data frame
        thiscase_events = event_log_df[['caseid','time','activity']][event_log_df['caseid']==thiscase]
        print(file = fcasedata)
        print('events for caseid',thiscase, file = fcasedata)
        print(thiscase_events, file = fcasedata)
        # compute inter-arrival times between cases
        thiscase_arrival_time = thiscase_events.loc[thiscase_events['activity']=='join_queue']['time'].max()
        inter_arrival_time = thiscase_arrival_time - lastcase_arrival_time
        inter_arrival_times.append(inter_arrival_time)
        print(file = fcasedata)
        print('time between arrivals (this case minus previous case):',inter_arrival_time, file = fcasedata)
        lastcase_arrival_time = thiscase_arrival_time # save for next case in loop
        # compute waiting times within this case (must have begin_service event)
        if thiscase_events.loc[thiscase_events['activity']=='begin_service'].shape[0] > 0:
            thiscase_begin_service = thiscase_events.loc[thiscase_events['activity']=='begin_service']['time'].min()
            thiscase_join_queue = thiscase_events.loc[thiscase_events['activity']=='join_queue']['time'].min()
            thiscase_waiting_time = thiscase_begin_service - thiscase_join_queue
            waiting_time.append(thiscase_waiting_time)
            print('waiting time for this case (time between joining queue and beginning service):',thiscase_waiting_time, file = fcasedata)
        # compute service time within this case (must have end_service event/activity)
        if thiscase_events.loc[thiscase_events['activity']=='end_service'].shape[0] > 0:
            thiscase_end_service = thiscase_events.loc[thiscase_events['activity']=='end_service']['time'].min()
            thiscase_service_time = thiscase_end_service - thiscase_begin_service
            service_time.append(thiscase_service_time)
            print('service time for this case (time between beginning and ending service):',thiscase_service_time, file = fcasedata)
    print()
    print('Summary statistics for customer inter-arrival times:')
    print(' Minimum: ',round(np.min(inter_arrival_times),2), ' seconds (',round(np.min(inter_arrival_times)/60,2), ' minutes)')
    print(' Mean: ',round(np.average(inter_arrival_times),2), ' seconds (',round(np.average(inter_arrival_times)/60,2), ' minutes)')
    print(' Maximum: ',round(np.max(inter_arrival_times),2), ' seconds (',round(np.max(inter_arrival_times)/60,2), ' minutes)')
    print()
    print('Summary statistics for customer wait times:')
    print(' Minimum: ',round(np.min(waiting_time),2), ' seconds (',round(np.min(waiting_time)/60,2), ' minutes)')
    print(' Mean: ',round(np.average(waiting_time),2), ' seconds (',round(np.average(waiting_time)/60,2), ' minutes)')
    print(' Maximum: ',round(np.max(waiting_time),2), ' seconds (',round(np.max(waiting_time)/60,2), ' minutes)')
    print()

```



```

print('Summary statistics for service times:')
print('  Minimum: ',round(np.min(service_time),2), ' seconds (' ,round(np.min(s
print('  Mean:     ',round(np.average(service_time),2), ' seconds (' ,round(np.
print('  Maximum: ',round(np.max(service_time),2), ' seconds (' ,round(np.max(s

```

Simulation parameter settings:

2 baristas/servers

Service time settings (in minutes)

minimum: 1

mean: 2

maximum: 5

Customers set to arrive every 5 minute(s) on average

Customers will not join the queue/waiting line if it has 6 customers in it (balking)

Customers will leave the queue/waiting line after waiting 6 minute(s) (reneging)

The simulation is set to run for 4 hours (240 minutes)

Results after 14335 seconds (238.92 minutes, 3.98 hours):

45 unique customers arrived

45 customers joined the queue for service

0 customers balked (lost business)

11 customers reneged (left queue, lost business)

34 customers began service

34 customers ended service

0 customers were still in line at the end of the simulation

\$170.00 average simulation revenue (assuming \$5 average ticket)

\$55.00 average lost revenue (balking & reneging)

\$144.00 simulation payroll costs

Summary statistics for customer inter-arrival times:

Minimum: 18 seconds (0.3 minutes)

Mean: 317.22 seconds (5.29 minutes)

Maximum: 1170 seconds (19.5 minutes)

Summary statistics for customer wait times:

Minimum: 0 seconds (0.0 minutes)

Mean: 0.15 seconds (0.0 minutes)

Maximum: 5 seconds (0.08 minutes)

Summary statistics for service times:

Minimum: 60 seconds (1.0 minutes)

Mean: 130.15 seconds (2.17 minutes)

Maximum: 300 seconds (5.0 minutes)

Evening Shift Simulation 2 - 6 P.M.

Define Staffing, Wait, Balking, Reneging

```

In [88]: #define staff
baristas = 2

#define service times (in minutes)
min_service_time = 1

```

```

mean_service_time = 2
max_service_time = 5

#define wait times (in minutes)
max_wait_time = 6

#define arrival pace (in minutes)
mean_inter_arrival_time = 10

#define balking tolerance (number of people in line)
balk_queue_length = 6

```

```

In [89]: #enable reproducible results
obtain_reproducible_results = True

#set simulation parameters
sim_hours = 4
fixed_sim_time = sim_hours * 60 * 60 #convert hours to seconds

#create parameter strings
parameter_strings_list = [str(sim_hours), 'hours',
                           str(baristas), str(min_service_time),
                           str(mean_service_time), str(max_service_time),
                           str(mean_inter_arrival_time), str(balk_queue_length),
                           separator = '-'
simulation_file_identifier = separator.join(parameter_strings_list)

```

```

In [90]: #set random seed
if obtain_reproducible_results:
    np.random.seed(9876)

#set simulation trace monitoring
simulation_data = []
this_trace_monitor = partial(trace_monitor, simulation_data)

env = simpy.Environment()
trace(env, this_trace_monitor)

env.process(test_process(env))

#set FIFO queue for caseid values
caseid_queue = queue.Queue()

#set limits on baristas resource
baristas_on_shift = simpy.Resource(env, capacity = baristas)
caseid = -1

#create event log tuple
event_log = [(caseid, 0, 'null_start_simulation')]
env.process(event_log_append(env, caseid, env.now, 'start_simulation', event_log))

#call customer arrival generator to start simulation
env.process(arrival(env, caseid, caseid_queue, event_log))

env.run(until = fixed_sim_time)

```

Out[90]: <Process(test_process) object at 0x7feb89119e50>

Out[90]: <Process(event_log_append) object at 0x7feb890f3460>

```
Out[90]: <Process(arrival) object at 0x7feb86901040>
```

Next arrival time: 107
Customer joins queue --> caseid = 1 , time = 107 , queue_length = 1
Next arrival time: 689
Begin_service --> caseid = 1 , time = 107 , queue_length = 1
End_service --> caseid = 1 , time = 385 , queue_length = 0
Customer joins queue --> caseid = 2 , time = 689 , queue_length = 1
Next arrival time: 1562
Customer 2 left the queue after waiting for 569 minutes
Customer joins queue --> caseid = 3 , time = 1562 , queue_length = 1
Next arrival time: 1994
Customer 3 left the queue after waiting for 1442 minutes
Customer joins queue --> caseid = 4 , time = 1994 , queue_length = 1
Next arrival time: 2055
Begin_service --> caseid = 4 , time = 1994 , queue_length = 1
Customer joins queue --> caseid = 5 , time = 2055 , queue_length = 1
Next arrival time: 2143
Begin_service --> caseid = 5 , time = 2055 , queue_length = 1
End_service --> caseid = 4 , time = 2068 , queue_length = 0
Customer joins queue --> caseid = 6 , time = 2143 , queue_length = 1
Next arrival time: 2548
Begin_service --> caseid = 6 , time = 2143 , queue_length = 1
End_service --> caseid = 6 , time = 2203 , queue_length = 0
End_service --> caseid = 5 , time = 2355 , queue_length = 0
Customer joins queue --> caseid = 7 , time = 2548 , queue_length = 1
Next arrival time: 2645
Customer 7 left the queue after waiting for 2428 minutes
Customer joins queue --> caseid = 8 , time = 2645 , queue_length = 1
Next arrival time: 2828
Begin_service --> caseid = 8 , time = 2645 , queue_length = 1
End_service --> caseid = 8 , time = 2705 , queue_length = 0
Customer joins queue --> caseid = 9 , time = 2828 , queue_length = 1
Next arrival time: 2915
Begin_service --> caseid = 9 , time = 2828 , queue_length = 1
Customer joins queue --> caseid = 10 , time = 2915 , queue_length = 1
Next arrival time: 3683
Begin_service --> caseid = 10 , time = 2915 , queue_length = 1
End_service --> caseid = 9 , time = 3035 , queue_length = 0
End_service --> caseid = 10 , time = 3055 , queue_length = 0
Customer joins queue --> caseid = 11 , time = 3683 , queue_length = 1
Next arrival time: 4914
Customer 11 left the queue after waiting for 3563 minutes
Customer joins queue --> caseid = 12 , time = 4914 , queue_length = 1
Next arrival time: 5804
Begin_service --> caseid = 12 , time = 4914 , queue_length = 1
End_service --> caseid = 12 , time = 5086 , queue_length = 0
Customer joins queue --> caseid = 13 , time = 5804 , queue_length = 1
Next arrival time: 5840
Begin_service --> caseid = 13 , time = 5804 , queue_length = 1
Customer joins queue --> caseid = 14 , time = 5840 , queue_length = 1
Next arrival time: 7286
Begin_service --> caseid = 14 , time = 5840 , queue_length = 1
End_service --> caseid = 13 , time = 5878 , queue_length = 0
End_service --> caseid = 14 , time = 6046 , queue_length = 0
Customer joins queue --> caseid = 15 , time = 7286 , queue_length = 1
Next arrival time: 7953
Begin_service --> caseid = 15 , time = 7286 , queue_length = 1
End_service --> caseid = 15 , time = 7377 , queue_length = 0
Customer joins queue --> caseid = 16 , time = 7953 , queue_length = 1
Next arrival time: 8634
Begin_service --> caseid = 16 , time = 7953 , queue_length = 1

```

End_service --> caseid = 16 , time = 8051 , queue_length = 0
Customer joins queue --> caseid = 17 , time = 8634 , queue_length = 1
Next arrival time: 10208
Begin_service --> caseid = 17 , time = 8634 , queue_length = 1
End_service --> caseid = 17 , time = 8751 , queue_length = 0
Customer joins queue --> caseid = 18 , time = 10208 , queue_length = 1
Next arrival time: 10321
Customer 18 left the queue after waiting for 10088 minutes
Customer joins queue --> caseid = 19 , time = 10321 , queue_length = 1
Next arrival time: 11581
Begin_service --> caseid = 19 , time = 10321 , queue_length = 1
End_service --> caseid = 19 , time = 10569 , queue_length = 0
Customer joins queue --> caseid = 20 , time = 11581 , queue_length = 1
Next arrival time: 11845
Begin_service --> caseid = 20 , time = 11581 , queue_length = 1
End_service --> caseid = 20 , time = 11698 , queue_length = 0
Customer joins queue --> caseid = 21 , time = 11845 , queue_length = 1
Next arrival time: 12635
Begin_service --> caseid = 21 , time = 11845 , queue_length = 1
End_service --> caseid = 21 , time = 11979 , queue_length = 0
Customer joins queue --> caseid = 22 , time = 12635 , queue_length = 1
Next arrival time: 12840
Customer 22 left the queue after waiting for 12515 minutes
Customer joins queue --> caseid = 23 , time = 12840 , queue_length = 1
Next arrival time: 13829
Customer 23 left the queue after waiting for 12720 minutes
Customer joins queue --> caseid = 24 , time = 13829 , queue_length = 1
Next arrival time: 14659
Customer 24 left the queue after waiting for 13709 minutes

```

```

In [91]: #create text file for simulation output
simulation_trace_file_name = 'simulation-program-trace-' + simulation_file_iden
with open(simulation_trace_file_name, 'wt') as ftrace:
    for d in simulation_data:
        print(str(d), file = ftrace)
print()
print('simulation program trace written to file:',simulation_trace_file_name)

# convert list of tuples to list of lists
event_log_list = [list(element) for element in event_log]

# convert to pandas data frame
caseid_list = []
time_list = []
activity_list = []
for d in event_log_list:
    if d[0] > 0:
        caseid_list.append(d[0])
        time_list.append(d[1])
        activity_list.append(d[2])
event_log_df = pd.DataFrame({'caseid':caseid_list,
                             'time':time_list,
                             'activity':activity_list})

#save event log to CSV file
event_log_file_name = 'simulation-event-log-' + simulation_file_identifier + '
event_log_df.to_csv(event_log_file_name, index = False)
print()
print('event log written to file:',event_log_file_name)

```

simulation program trace written to file: simulation-program-trace-4-hours-2-1-2-5-10-6-6.txt

event log written to file: simulation-event-log-4-hours-2-1-2-5-10-6-6.csv

In [92]: `event_log_df.head()`

Out[92]:

	caseid	time	activity
0	1	107	arrival
1	1	107	join_queue
2	1	107	begin_service
3	1	385	end_service
4	2	689	arrival

In [93]:

```
avg_ticket = 5
sim_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='end_serv
lost_revenue = (len(event_log_df['activity'])[event_log_df['activity']=='balk'])
barista_wages = 18 #per hour
sim_payroll = baristas * barista_wages* sim_hours

#print simulation results
print()
print('Simulation parameter settings:')
print(baristas, 'baristas/servers')
print(' Service time settings (in minutes)')
print('    minimum:',min_service_time)
print('    mean:    ',mean_service_time)
print('    maximum:',max_service_time)
print()
print('Customers set to arrive every', mean_inter_arrival_time, 'minute(s) on a
print('Customers will not join the queue/waiting line if it has',balk_queue_len
print('Customers will leave the queue/waiting line after waiting', max_wait_tim
print('The simulation is set to run for ', sim_hours,' hours (',60 * sim_hours
print()
end_time = np.max(event_log_df["time"])
print('Results after ',end_time, ' seconds (', round(end_time/60, 2), ' minutes
caseid_list = pd.unique(event_log_df['caseid'])
print(len(caseid_list), 'unique customers arrived')
print(len(event_log_df['activity'])[event_log_df['activity']=='join_queue']), 'cu
print(len(event_log_df['activity'])[event_log_df['activity']=='balk']), 'custome
print(len(event_log_df['activity'])[event_log_df['activity']=='renege']), 'custor
print(len(event_log_df['activity'])[event_log_df['activity']=='begin_service']),
print(len(event_log_df['activity'])[event_log_df['activity']=='end_service']), 'c
print(caseid_queue.qsize()), 'customers were still in line at the end of the simu
print()
print(f'${sim_revenue:.2f} average simulation revenue (assuming ${avg_ticket} a
print(f'${lost_revenue:.2f} average lost revenue (balking & renege)')
print(f'${sim_payroll:.2f} simulation payroll costs')

# case-by-case logs are very useful for checking the logic of the simulation
case_by_case_event_file_name = 'simulation-program-case-by-case-events-' + sim
with open(case_by_case_event_file_name, 'wt') as fcasedata:
    lastcase_arrival_time = 0 # initialize for use with first case
    # create lists for storing time interval data
    inter_arrival_times = [] # computed across cases
```

```

waiting_time = [] # computed within each case that has begun service
service_time = [] # computed within each case that has ended service
for thiscase in caseid_list:
    # select subset of rows for thiscase and use as a Pandas data frame
    thiscase_events = event_log_df[['caseid','time','activity']][event_log.
    print(file = fcasedata)
    print('events for caseid',thiscase, file = fcasedata)
    print(thiscase_events, file = fcasedata)
    # compute inter-arrival times between cases
    thiscase_arrival_time = thiscase_events.loc[thiscase_events['activity']
    inter_arrival_time = thiscase_arrival_time - lastcase_arrival_time
    inter_arrival_times.append(inter_arrival_time)
    print(file = fcasedata)
    print('time between arrivals (this case minus previous case):',inter_a
    lastcase_arrival_time = thiscase_arrival_time # save for next case in
    # compute waiting times within this case (must have begin_service event)
    if thiscase_events.loc[thiscase_events['activity']=='begin_service'].sh
        thiscase_begin_service = thiscase_events.loc[thiscase_events['acti
        thiscase_join_queue = thiscase_arrival_time = thiscase_events.loc[
        thiscase_waiting_time = thiscase_begin_service - thiscase_join_que
        waiting_time.append(thiscase_waiting_time)
        print('waiting time for this case (time between joining queue and l
    # compute service time within this case (must have end_service event/a
    if thiscase_events.loc[thiscase_events['activity']=='end_service'].shap
        thiscase_end_service = thiscase_events.loc[thiscase_events['activi
        thiscase_service_time = thiscase_end_service - thiscase_begin_serv
        service_time.append(thiscase_service_time)
        print('service time for this case (time between beginning and endin

print()
print('Summary statistics for customer inter-arrival times:')
print('  Minimum: ',round(np.min(inter_arrival_times),2), ' seconds (' ,round(
print('  Mean:      ',round(np.average(inter_arrival_times),2), ' seconds (' ,rou
print('  Maximum: ',round(np.max(inter_arrival_times),2), ' seconds (' ,round(
print()
print('Summary statistics for customer wait times:')
print('  Minimum: ',round(np.min(waiting_time),2), ' seconds (' ,round(np.min(
print('  Mean:      ',round(np.average(waiting_time),2), ' seconds (' ,round(np.
print('  Maximum: ',round(np.max(waiting_time),2), ' seconds (' ,round(np.max(
print()
print('Summary statistics for service times:')
print('  Minimum: ',round(np.min(service_time),2), ' seconds (' ,round(np.min(
print('  Mean:      ',round(np.average(service_time),2), ' seconds (' ,round(np.
print('  Maximum: ',round(np.max(service_time),2), ' seconds (' ,round(np.max(

```

Simulation parameter settings:

2 baristas/servers

Service time settings (in minutes)

minimum: 1

mean: 2

maximum: 5

Customers set to arrive every 10 minute(s) on average

Customers will not join the queue/waiting line if it has 6 customers in it (balking)

Customers will leave the queue/waiting line after waiting 6 minute(s) (reneging)

The simulation is set to run for 4 hours (240 minutes)

Results after 13829 seconds (230.48 minutes, 3.84 hours):

24 unique customers arrived

24 customers joined the queue for service

0 customers balked (lost business)

8 customers reneged (left queue, lost business)

16 customers began service

16 customers ended service

0 customers were still in line at the end of the simulation

\$80.00 average simulation revenue (assuming \$5 average ticket)

\$40.00 average lost revenue (balking & reneging)

\$144.00 simulation payroll costs

Summary statistics for customer inter-arrival times:

Minimum: 36 seconds (0.6 minutes)

Mean: 576.21 seconds (9.6 minutes)

Maximum: 1574 seconds (26.23 minutes)

Summary statistics for customer wait times:

Minimum: 0 seconds (0.0 minutes)

Mean: 0.0 seconds (0.0 minutes)

Maximum: 0 seconds (0.0 minutes)

Summary statistics for service times:

Minimum: 60 seconds (1.0 minutes)

Mean: 148.5 seconds (2.48 minutes)

Maximum: 300 seconds (5.0 minutes)