PART 3

Simulation - ABC Wash Machine

ABC Wash Machine

- ABC Wash Machine provides a self-wash car for its customer.
  - The customer queue up to get the service.
  - The customer will immediately be served if the queue is empty.
  - If the machine is free, it will serve the front customer in the queue.
  - The machine takes 5 minutes to complete one service.
  - The machine operation starts at 8.00 am and ends at 8.30 am.
  - It will serve all customers that arrive before or by 8.30 am.
- Simulation Complexity

1 Machine	1 type of service	many customer
Server	Service – 5 mininutes	Arrival time (rand)

- **Input**: customer's arrival time (rand)
- **Output** statistical informations:
  - Number of customer that arrives by 8.30 am.
  - Longest customer waiting time.
  - Average customer waiting time.

The algorithm for ABC Wash Machine simulation:

Set the operation time.
*Generate all car arrivals, and push them onto **arrival queue**.*
Set the initial state for the wash machine (status, startWash, endWash)
Set current event.

While there is still an event

If car arrival event occurs:
Push car onto waiting queue.
If machine finish washing
Update machine state.
If machine available and there is a car waiting:
Front car in waiting queue will be washed.
Remove this car from waiting queue.
Update the machine state and statistical information.
If machine available and there is no car waiting:
Update endWash to beyond operation time.
Jump to the next earliest event that is either car arrival or machine finish washing.

Produce report.

Set the operation time.
Generate all car arrivals, and push them onto ***arrival queue****.*

```
31          startTime.setTime(8,0,0);
32          endTime.setTime(8,30,0); // can change to 12 pm
33
34          for (i=startTime.getCopy();i.lessThan(endTime); ){
35                  nextArrival = rand.nextInt(10); nextArrival in the range 0 to 9
36                  i.addTimeMinute(nextArrival);
37                  if(i.lessThan(endTime)) {
38                     arrivalQueue.enqueue(i.getCopy());
39                     System.out.println("car arrival: " + i.toString() + " < " +
40                                                 endTime.toString());
41                  }
42          }
43
```

Set the initial state for the wash machine (status, startWash, endWash)
Set current event.

```
44          //start the simulation
45          machineWash=status.free;
46          if (!arrivalQueue.isEmpty()) {
47                  startTime=arrivalQueue.peek();
48                  washEnd=startTime.getCopy();
49                  washEnd.addTimeMinute(5);
50          } else
51                  startTime=endTime.getCopy();
52
```

```
54          for
55          (i=startTime;(i.lessThan(endTime)||(!waitQueue.isEmpty())||(!arrivalQueue.isEmpty()));)
56          {
57                  if (!arrivalQueue.isEmpty())
58                          if (i.equalTime(arrivalQueue.peek())) {
59                                  waitQueue.enqueue(i.getCopy());
60                                  del=arrivalQueue.dequeue();
61                          }
62
63                          if ((machineWash==status.busy) && (i.equalTime(washEnd))) {
64                                  washEnd.setTime(14,0,0);
65                                  machineWash=status.free;
66                          }
67
68                          if ((machineWash==status.free) && !(waitQueue.isEmpty())) {
69                                  washStart=i.getCopy();
70                                 washEnd=i.getCopy(); washEnd.addTimeMinute(5);
71                                  doAnalysis(i,waitQueue.peek(),washEnd); // call doAnalysis method
72                                  del=waitQueue.dequeue();
73                                  machineWash=status.busy;
74                          }
```

While there is still an event

If car arrival event occurs:
Push car onto waiting queue.
If machine finish washing
Update machine state.
If machine available and there is a car waiting:
Front car in waiting queue will be washed.
Remove this car from waiting queue.
Update the machine state and statistical information.
If machine available and there is no car waiting:
Update endWash to beyond operation time.
Jump to the next earliest event that is either car arrival or machine finish washing.

While there is still an event

> *If car arrival event occurs:*
> *Push car onto waiting queue.*
> *If machine finish washing*
> *Update machine state.*
> *If machine available and there is a car waiting:*
> *Front car in waiting queue will be washed.*
> *Remove this car from waiting queue.*
> *Update the machine state and statistical information.*
> *If machine available and there is no car waiting:*
> *Update endWash to beyond operation time.*
> *Jump to the next earliest event that is either car arrival or machine finish washing.*

```
75
76                  if ((machineWash==status.free) && (waitQueue.isEmpty()))
77                      washEnd.setTime(14,0,0);
78
79                  //jump to next event.
80                  if (!arrivalQueue.isEmpty())
81                      if (washEnd.lessThan(arrivalQueue.peek())) {
82                          i=washEnd.getCopy();
83                      }
84                      else {
85                          i=arrivalQueue.peek().getCopy();
86                      }
87                  else  {
88                      i=washEnd.getCopy();
89                  }
90          }
```

Output Example 1-ABC Wash Machine

car arrival: 08:01:00 < 08:30:00
car arrival: 08:09:00 < 08:30:00
car arrival: 08:16:00 < 08:30:00
car arrival: 08:16:00 < 08:30:00
car arrival: 08:19:00 < 08:30:00
car arrival: 08:25:00 < 08:30:00

REPORT
Number of customer arrive by 8.30 am: 6
Longest waiting time: 7 minutes
Average waiting time: 3.00 minutes

Example 2-ABC Wash Machine

```
car arrive: 08:00:00 < 08:30:00  startWash: 08:00:00 front car waitQueue : 08:00:00 washEnd: 08:05:00
                                 carWait: 0 maxDur: 0 TotalWait: 0 TotalWork: 5

car arrive: 08:05:00 < 08:30:00  startWash: 08:05:00 front car waitQueue : 08:05:00 washEnd: 08:10:00
                                 carWait: 0 maxDur: 0 TotalWait: 0 TotalWork: 10

car arrive: 08:11:00 < 08:30:00  startWash: 08:11:00 front car waitQueue : 08:11:00 washEnd: 08:16:00
                                 carWait: 0 maxDur: 0 TotalWait: 0 TotalWork: 15

car arrive: 08:20:00 < 08:30:00  startWash: 08:20:00 front car waitQueue : 08:20:00 washEnd: 08:25:00
                                 carWait: 0 maxDur: 0 TotalWait: 0 TotalWork: 20

car arrive: 08:26:00 < 08:30:00  startWash: 08:26:00 front car waitQueue : 08:26:00 washEnd: 08:31:00
                                 carWait: 0 maxDur: 0 TotalWait: 0 TotalWork: 25

car arrive: 08:27:00 < 08:30:00  startWash: 08:31:00 front car waitQueue : 08:27:00 washEnd: 08:36:00
                                 carWait: 4 maxDur: 4 TotalWait: 4 TotalWork: 30

                                 REPORT
                                 Number of customer arrive by 8.30 am: 6
                                 Longest waiting time: 4 minutes
                                 Average waiting time: 0.67 minutes
```