Decision Science
Assessment 2: Programming Assignment

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November 7, 2023

1 Schematic

Figure 1 below is the schematic of the system. When the orders come into the factory, they automatically go to the waiting queue, and the queue is infinite and FIFO (first in first out). When the order goes from the waiting queue to the machine for production, the machine is likely broken, and then the machine status will go to breakdown wait to be repaired immediately. During the breakdown and repair status, all newly arrived orders will go to the queue continuously but no order can be moved to the machine for production.

2 States

The overall events can be divided into four parts, which are arrival, departure, breakdown and repair. There are two states for those four events under this simulation.

- The machine is **working**: the order will continuously go to the waiting queue, and the machine will work so that the order finishes production and leaves.
- The machine is **down**: the machine is down and it is on "vacation". The machine will stop working but the orders will arrive and wait to be produced.

3 Entity

The entity of this simulation is the order of lawnmowers.

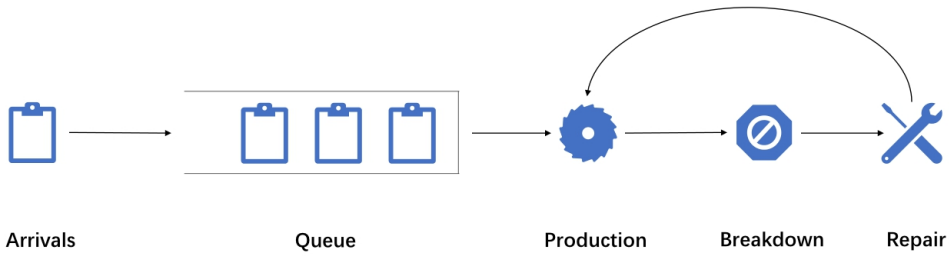

Figure 1: The schematic of the system

4 Types of Events

1. **Arrival**: The event in which an order will come into the factory. $N(t+\epsilon) < -N(t) + 1$
   - Creating an arriving arrival and adding it to the waiting queue at $t + X$, where t is the current time and X is the inter-arrival time.
   - It is created when the machine finishes production and departs the factory.
   - If the machine is working and available now, push the current order into the machine and start production.
2. **Departure**: The event in which an order will complete production and leave the factory. $N(t+\epsilon) < -N(t) - 1$
   - If $N(t+\epsilon) = 0$, then the waiting queue is empty.
   - Since the machine has finished production, the machine now is available. If it is working and the waiting queue is not empty, move the first in order for the machine to be produced.
3. **Breakdown**: The event in which the machine is down and cannot work.
   - Generating a repair event, and the repair time should be included for this event.

- The machine is down under this event, so no more orders should be added now.
- It is likely that the machine is down during production, so it is necessary to track if any order is interrupted. After the repair, the interrupted order will be produced and the departure time will be updated (repair time added).

4. **Repair**: The event in which the machine is repaired after the breakdown.
    - Creating another breakdown event and adding it to the event queue.
    - After repair, the machine is working now, set the machine status back to the normal status.
    - If the order is interrupted, then the machine will continue to produce. If no order is interrupted and the waiting queue is not empty, then push the first in order for the machine to be produced.

5 Flowchart

Figure 2 below is the flowchart of the simulation structure.

- The first step is to test if there is any upcoming order. If yes, then go to the events, if not, then terminate the simulation.
- There are four different types of events and all detailed information is demonstrated in the Type of Events section. The following steps are divided into two parts, arrival and departure when the machine is working, and breakdown and repair when the machine is down, which are based on the two different states in the States section.
- If the machine is working and available, and the waiting queue is not empty, then the new order will be moved into service and depart the factory.
- If the machine breaks, the repair event will come immediately, and after repair, if there is any order is interrupted, then it will continue the previous order and go back to the normal state. Otherwise, it will go back to the normal state straightforward.
- There will be only "vacation" when the machine is down and repaired.

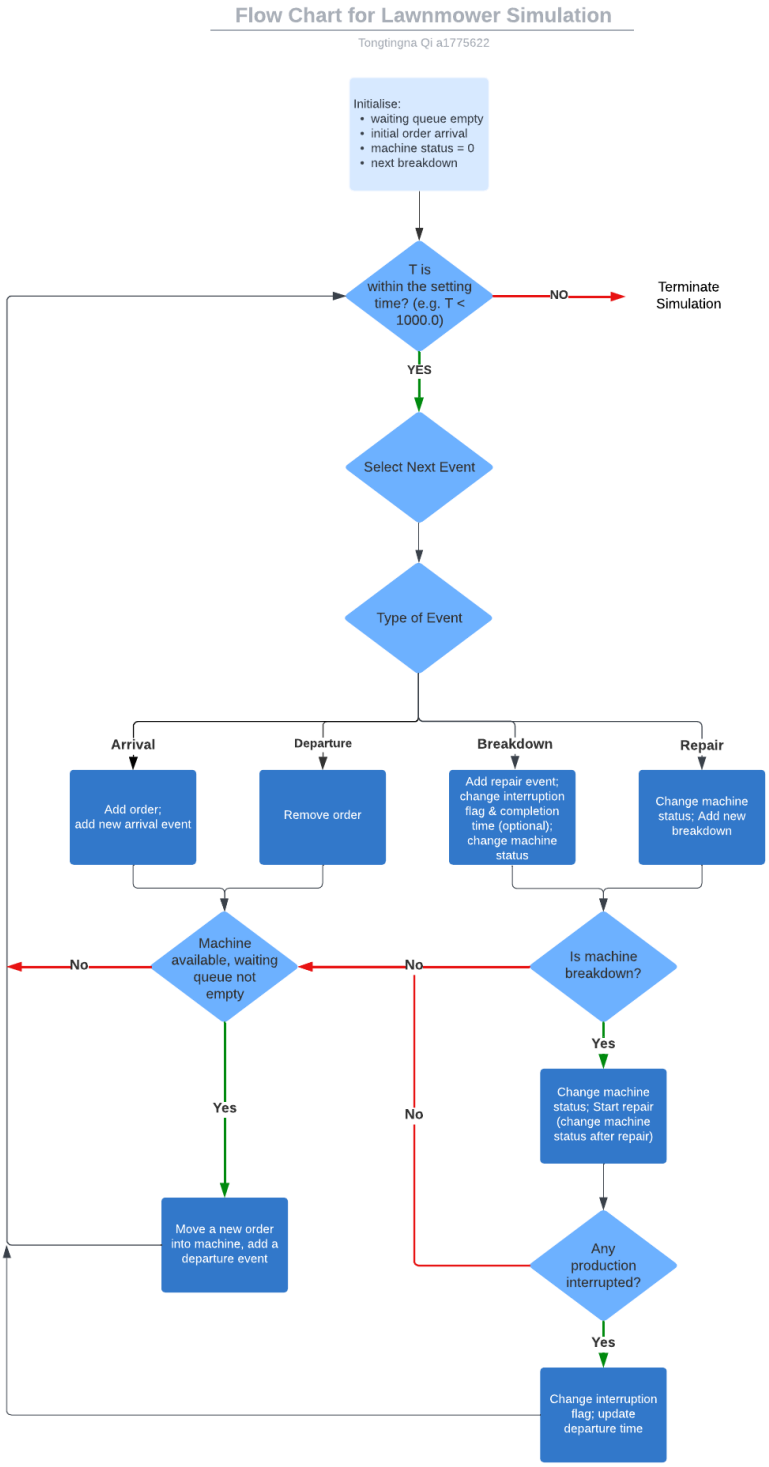

Figure 2: The schematic of the system

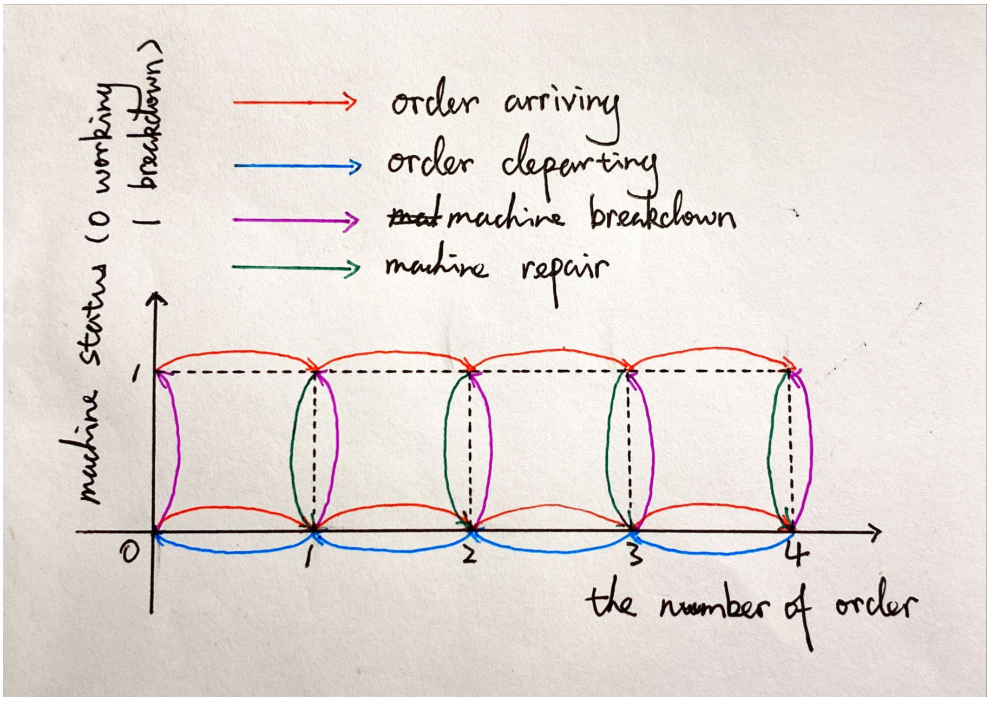

Figure 3: The schematic of the system

6 State Diagram

Figure 3 is the state diagram of the system.

- The x-axis is the number of orders, which is the discrete number, and the number of orders is finite in this simulation. The y-axis is the machine status, with 0 representing working and 1 for breakdown.
- The order will continuously arrive no matter what the machine status is, but the order will only depart when the machine is working. Regarding the machine, the machine is likely down at times, so it does not have to be broken only when the machine is free. Therefore, it is likely that breakdown and repair happen in any state (order).
- There is no event of machine repair when there is no order in the waiting queue since it is impossible in this simulation that the repair time is less than the next arrival time. It is, however, a factor which should be considered when the repair time is less than the mean inter-arrival time.