Service line simulation project

This project is about developing an event-driven simulation. To prepare for designing and developing the event-driven simulation, I first developed several data structures to store the data, including double linked list and Fist-in-first-out queue.

The simulation to implement is a server simulation at a fast food restaurant. Customers come into the restaurant on a pseudo-random basis, where each customer enters the restaurant some amount of time after the previous customer. The amount of time between customers is drawn from a uniform distribution, which has specified min and max values. The restaurant will have only a single server. If the server is not currently waiting on a customer, a new customer can immediately get served. Otherwise, the customer will have to wait in a first-in-first-out queue and wait their turn. The amount of time it takes for the server to wait on the customer will be drawn from a normal distribution with a specified mean and standard deviation.

My simulation provides a lot of console output to allow a user to easily follow and understand what is happening at the restaurant. And at the end of the program, I provide some basic statistics to summarize the whole simulation.

Like the image editing project, I give out an example of simulation below, makefile compiles the files and run the executable file:

```
$ make
g++ -c main.cpp -o main.o
g++ -c random.cpp -o random.o
g++ -c event.cpp -o event.o
g++ -c customer.cpp -o customer.o
g++ -c server.cpp -o server.o
g++ main.o random.o event.o customer.o server.o -o main.exe
$ ./main.exe
```

Then the program will ask user to set several initial parameters for the simulation (input error handling is complete, any invalid input will be asked to correct):

```
Defaut constant values list:
Random Seed Value: 2018
Uniformed distribution used to describe customer arrival.
min value: 5
max value: 10
Normal distribution describes server's serving speed.
```

```
mean value: 7
standard deviation: 4
restaurant closing time: 100
```

Here I set 100 to be the closing time for the restaurant, which means after time 100, the restaurant will stop taking in new costumers but will finish serving the remaining costumers. Then the simulation begins and follow by the statistics summarization.

```
At Time: 7  customer 1 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 13  server finish serving customer 1  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 13  customer 2 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 19  customer 3 arrived. server is busy, so customer is waiting in the queue.
There are 2 in the waiting line.
 (customer being served included)

At Time: 25  server finish serving customer 2  and begin to server another customer
There are 1 in the waiting line

At Time: 25  customer 4 arrived. server is busy, so customer is waiting in the queue.
There are 2 in the waiting line.
 (customer being served included)

At Time: 31  server finish serving customer 3  and begin to server another customer
There are 1 in the waiting line

At Time: 32  customer 5 arrived. server is busy, so customer is waiting in the queue.
There are 2 in the waiting line.
 (customer being served included)
```

```
At Time: 37  customer 6 arrived. server is busy, so customer is waiting in the queue.
There are 3 in the waiting line.
 (customer being served included)

At Time: 39  server finish serving customer 4  and begin to server another customer
There are 2 in the waiting line

At Time: 46  customer 7 arrived. server is busy, so customer is waiting in the queue.
There are 3 in the waiting line.
 (customer being served included)

At Time: 47  server finish serving customer 5  and begin to server another customer
There are 2 in the waiting line

At Time: 50  server finish serving customer 6  and begin to server another customer
There are 1 in the waiting line

At Time: 54  customer 8 arrived. server is busy, so customer is waiting in the queue.
There are 2 in the waiting line.
 (customer being served included)

At Time: 56  server finish serving customer 7  and begin to server another customer
There are 1 in the waiting line

At Time: 59  server finish serving customer 8  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 63  customer 9 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 71  server finish serving customer 9  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 73  customer 10 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
```

```
 (customer being served included)

At Time: 73  server finish serving customer 10  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 79  customer 11 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 85  server finish serving customer 11  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 86  customer 12 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 90  server finish serving customer 12  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 96  customer 13 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 100  server finish serving customer 13  wait for the next customer to arrive
There are 0 in the waiting line

At Time: 103  customer 14 arrived. server is not busy, so customer get served directly.
There are 1 in the waiting line.
 (customer being served included)

At Time: 104  server finish serving customer 14  wait for the next customer to arrive
There are 0 in the waiting line

#--------------------Statistics Summary--------------------#
Constant values list:
Uniformed distribution used to describe customer arrival.
```

```
min value: 5   max value: 10
Normal distribution describes server's serving speed.
mean value: 7   standard deviation: 4

Simulation Result:
Total simulation time: 104
1. Total number of customers simulated: 14
2. Percentage of time the server was busy helping customers: 72.1154%
3. What percentage of customers had to wait in line: 42.8571%
4. The longest of line was throughout the simulation: 3
5: The average waiting time is: 2.5
6: The average serving time is: 5.35714
7: The longest waiting time is: 10
8: The longest serving time is: 12
9: When the restaurant closed, there are still people waiting inline
So Server need to spend extra: 4 minutes in the restaurant because the overcrowded situation.
```

More details about the project, please refer to my github website:
https://github.com/QuantLee/CppProject/serviceSimulation