APIs for library:

In this project, we didn’t use some other APIs or existing data structures/ libraries to implement the library. We define all the data structures in application and engine files.

Implementation of the library:

The library can be divided into two parts, one is engine and another is application.

In files engine.h and engine.c, we simply used the file provided by instructor, the functions included are as below.

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| Function | Functionality |
| RunSim() | Used to remove the event with the highest timestamp in the priority queue, and input it into EventHandler() function in application files. |
| Schedule() | Used to insert the new event from application files into the priority queue. |
| CurrentTime() | Used to return the system current time, the default value is 0.0. |
| \*Remove() | Used to remove the element from priority queue. |
| PrintList() | Print the list of event to the screen to monitor the process |

In files application.h and application.c, the main struct we define are as below.

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| Struct | Properties | Description |
| Customer | CreationTime | Record the time customer is generated |
| ArrTime | Record the time customer arrive at station, and being added into a queue |
| totalWait | Total waiting time in the system |
| CustomerList | amount | The total number of customers in the list, which is used to record the information of all the customers |
| \*head | The head of the list |
| EventData | EventType | Type of event(GENERATE, ARRIVAL, DEPARTURE) |
| \*Cust | Arriving or departing customers; unused for GENERATE events |
| CompID | ID of component where customer created, arrives or departs |
| FIFOQueue | \*first | Pointer to first customer in queue |
| \*last | Pointer to last customer in queue |
| Generator | IntArrTime | Mean interarrival time for generated components |
| DestComp | ID of next component customers are sent to |
| Queue\_Station | \*Q | A FIFO queue in station |
| AvgWaitTime | Average total waiting time for all customers in the station |
| totalWait | Total waiting time in the station |
| inLine | Number of customers in line |
| DestComp | ID of next component customers are sent to |
| Fork | num | number of ports it has |
| \*probability | probabilities for each port |
| \*DestComp | D of next component customers are sent to |
| Exit | Count | The number of customers that exited at this component |
| totalTime | System total service time and wait time for all customers |
| maxTime | The maximum time a customer stayed in the system |
| minTime | The minimum time a customer stayed in the system |
| Component[] | ComponentType | GENERATOR, QUEUE\_STATION, FORK, EXIT |
| \*Comp | Pointer to information on component (Generator, Exit struct, etc.) |

In application.c, we also defined global variables to record the customer information.

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| Global variable | Description |
| \*CustList | Used a linked list to record all customer information |
| totalExits | Total number of customers that exited from the system |
| numComponents | Number of components in the system |

In implementation. Firstly we initialize the Customer List, and make all the components according to the input file. Initialize all the components in each function. While making the Generator component, we schedule the first event and put it into the engine. Then we iteratively remove the event from the priority queue and use EventHandler to handle each different type of event.

If the event type is GENERATOR, we make a new customer, and add it to the Customer List. Then we schedule ARRIVAL event at the component it connected. Then we schedule next GENERATION event with timestamp generated from an exponential distribution with mean U, where U is the mean interarrival time of generation.

If the event type is ARRIVAL, then we need to check which component it arrives. If the customer arrives at Queue Station component, if the queue in this station is empty, we schedule DEPARTURE event for this customer with timestamp at current time. The component ID is still the same as this component; If the queue is not empty, we add the customer in to queue, and record its arrive time. If the customer arrives at Fork component, we firstly random select a port with their probabilities. Then we schedule an ARRIVAL event at the port we choose. If the customer arrives at Exit component, we simply record its leaving time, and calculate its total time in the system.

If the event type is DEPARTURE, we can only have a DEPARTURE event at Queue Station. We firstly schedule ARRIVAL event for the customer who is the first in queue at the component it connected, with timestamp generated from an exponential distribution with mean V, where V is the mean service time of this station, and remove this customer from the queue. Then if the queue in this station is not empty, we schedule DEPARTURE event for the next customer (who is now the first of the queue), with timestamp at current time. The component ID is still the same as this component.

After running RunSim() in the time we set, we can calculate different statistics for the whole system, and output them in files.

We wrote the random number generation functions in random.h and random.c and include them in application.c. There’re three functions in these files.

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| Functions | Functionality |
| rand\_init() | Initialize random function to set time seed |
| urand () | Generate a random number uniformly distributed over the interval [0,1) |
| randexp() | Returns -U\*(log(1-urand())), where log() is the C function defined in <math.h>, and U is the mean |