Queue-Wait-Time for MM1

W. M. Song 桑慧敏
Tsing Hua Univ. 清華大學

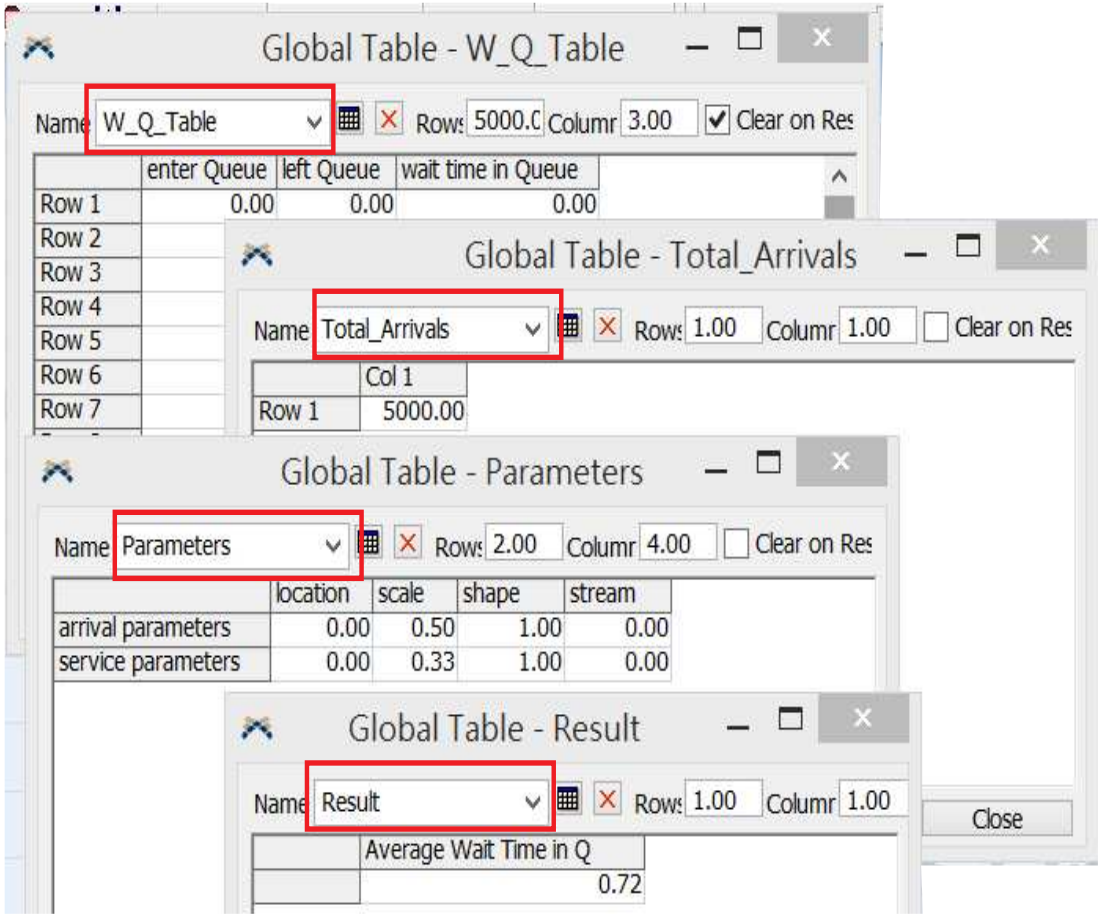
2015.10.20

- Goal: To obtain the queue-wait-time for the i^{th} customer, $\mathrm{W_Q}(i)$. $i = 1, 2, \ldots, n$
- Model: MM1 with arrival rate and service rate stored in Global Tables, named "Parameters".
  - Construct MM1 via Flexsim
  - Construct Global Table (see page 4)
  - Learn New Flexsim Functions (see page 5)
  - Create and Initialize Label (See page 7)
  - Learn stopping rule, no. of arrivals (See page 7)
  - Set label number (See pages 8 - 10)
  - Record W_Q (See Page 12)

Data in Global Tables

Tables

- W_Q_Table
- Total_Arrivals
- Parameters
- Result



Flexsim Data Types and Functions

Data Type

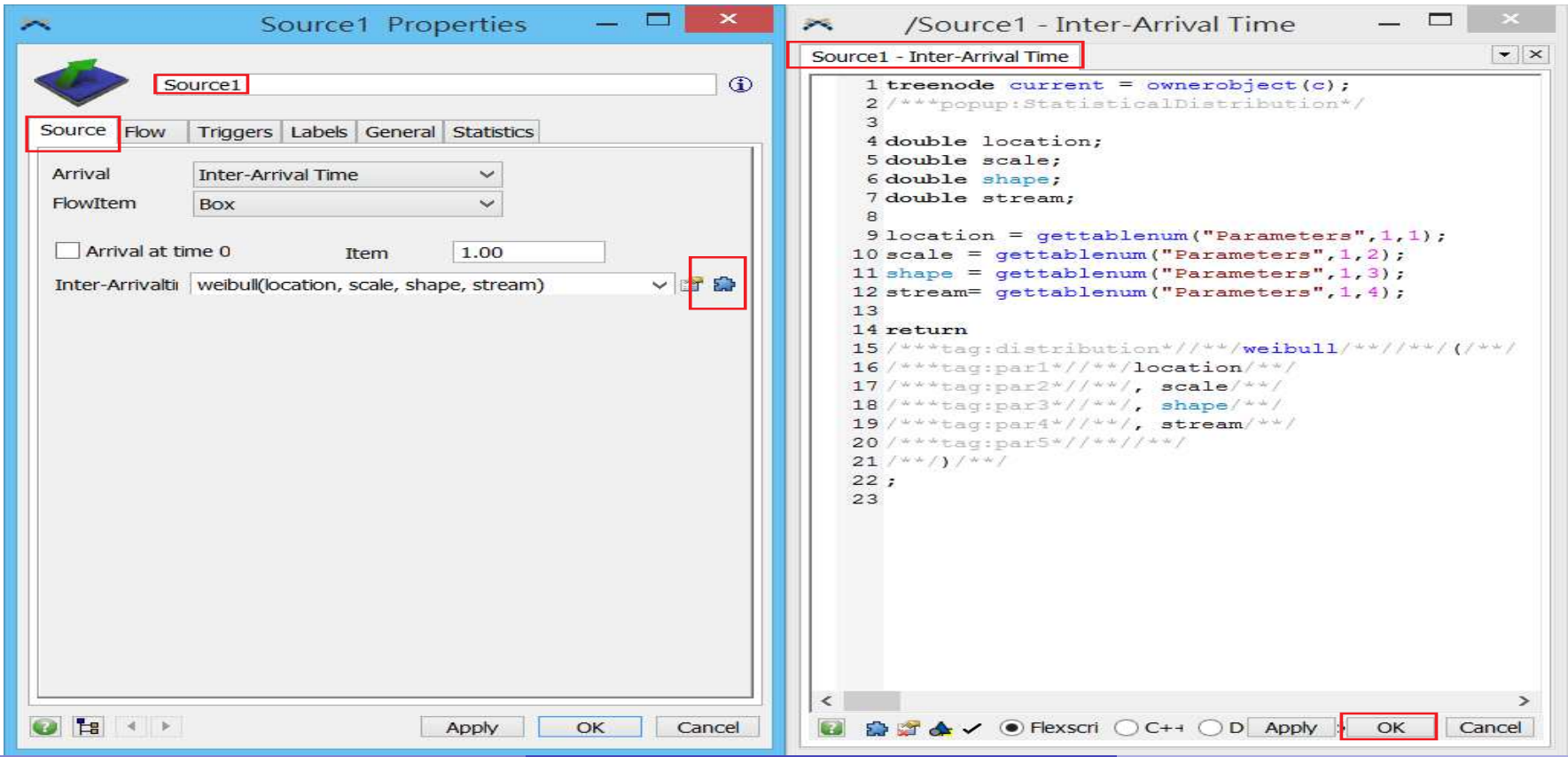
- int: integer (整數)
- double: real value (實數)
- string: (字串)
- treenode: (Flexsim 特有的 Data Type)

Flexsim Functions

- getoutput(current)
- getinput(current)
- getlabelnum(item,"labelname")
- setlabelnum(item,"labelname",time())
- gettabelnum("tablename", i-row, j-column)
- settabelnum("tablename", i-row, j-column, enter-queue-time)

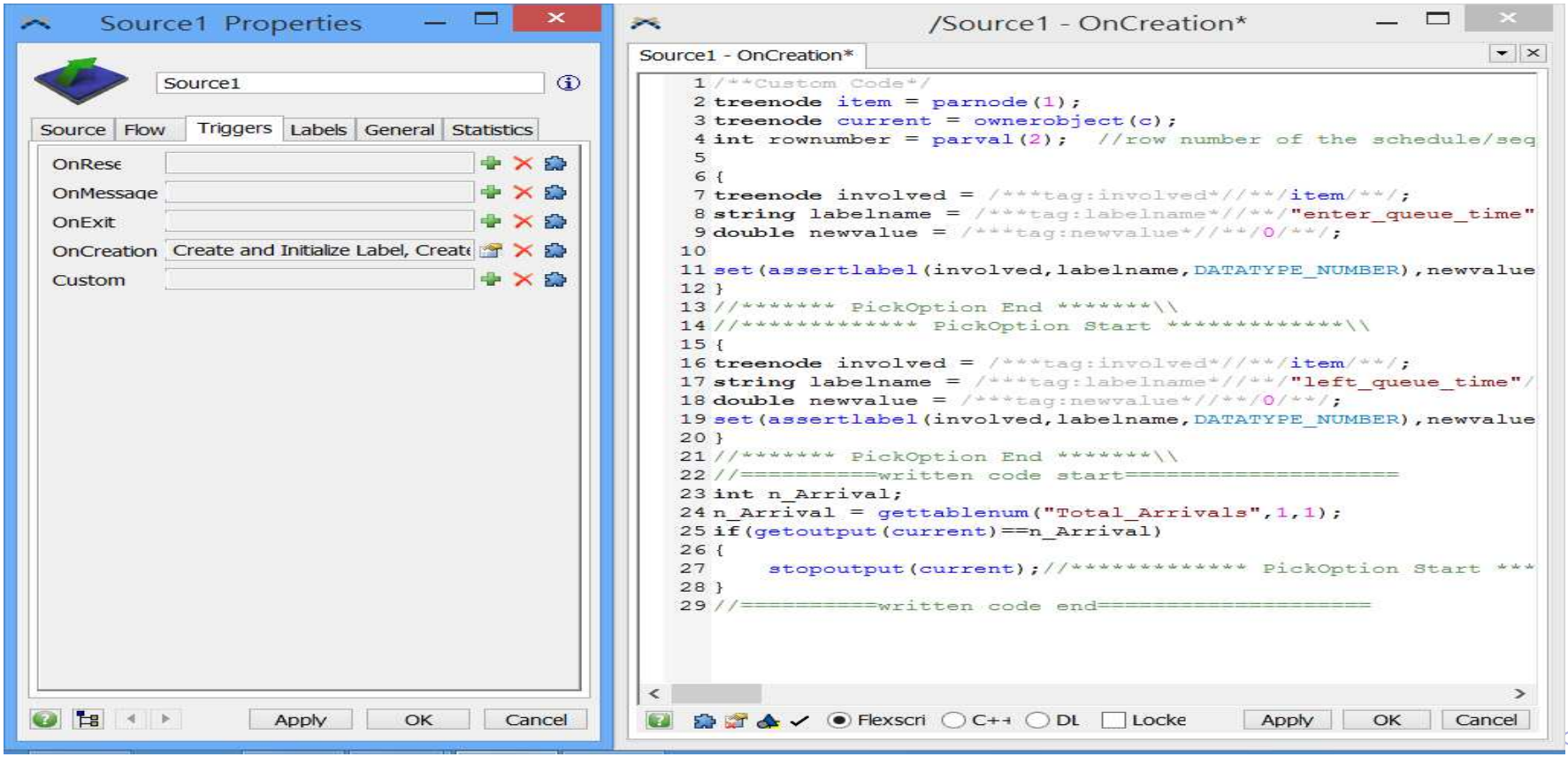
Generate Inter-arrival Times

- Weibull with para. location, scale, and shape
- Parameters are stored in Global Tables



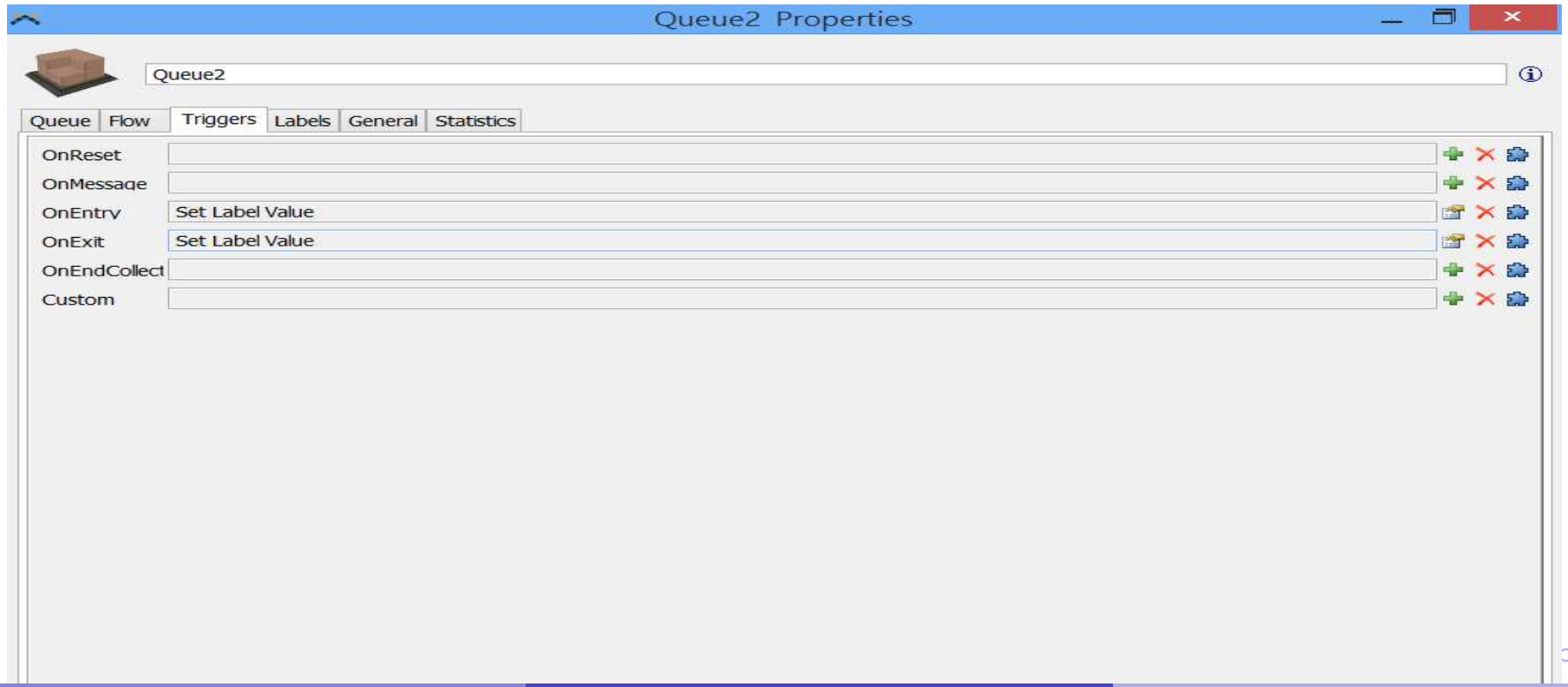
Stop Rule: Total arrivals

- Source > Trigger > OnCreation
- Add “Create and Initialize” twice: enter-queue-time; left-queue-time
- Reset > Run > Stop, then click ”item” to see what happens



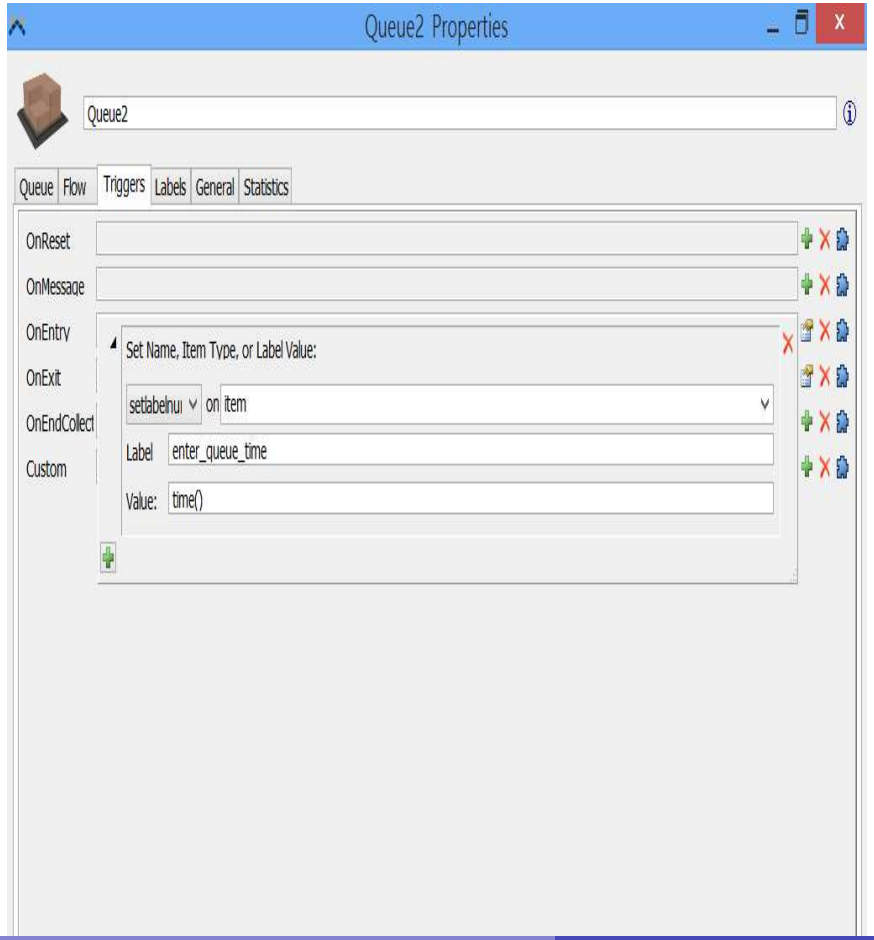
Record time entering and leaving Queue

- Queue > Trigger > OnEntry
- Queue > Trigger > OnExit



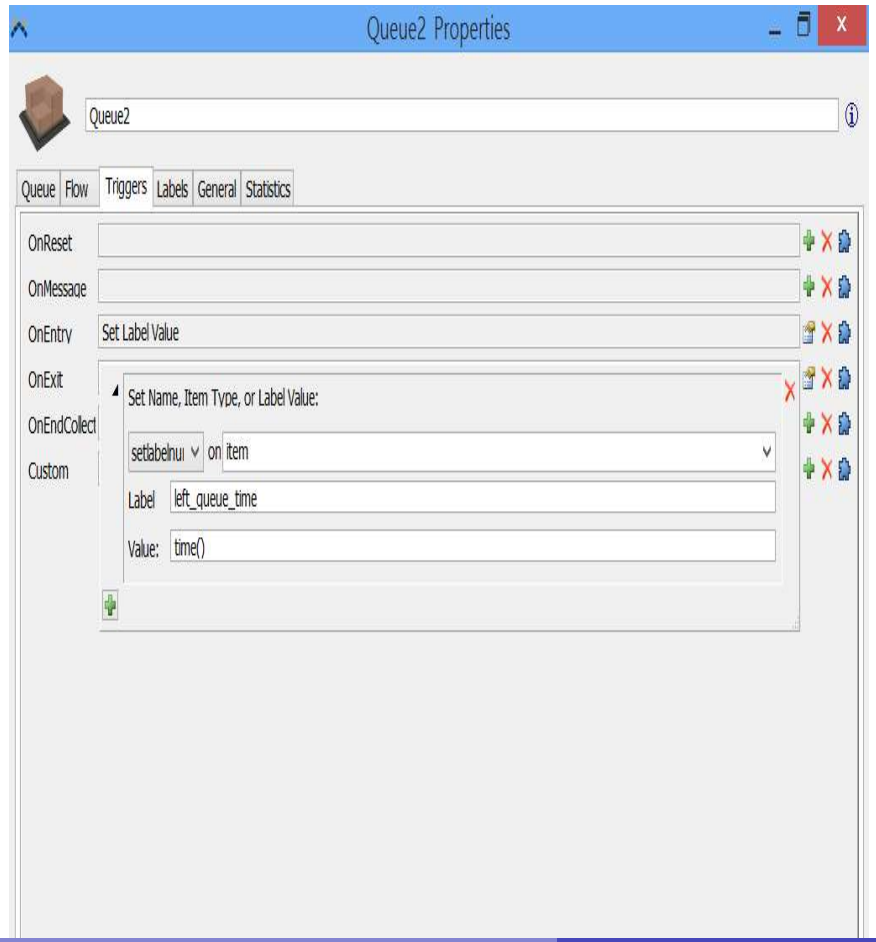
Record Time Entering Queue

- setlablenum (item, "enter_queue_time", time())



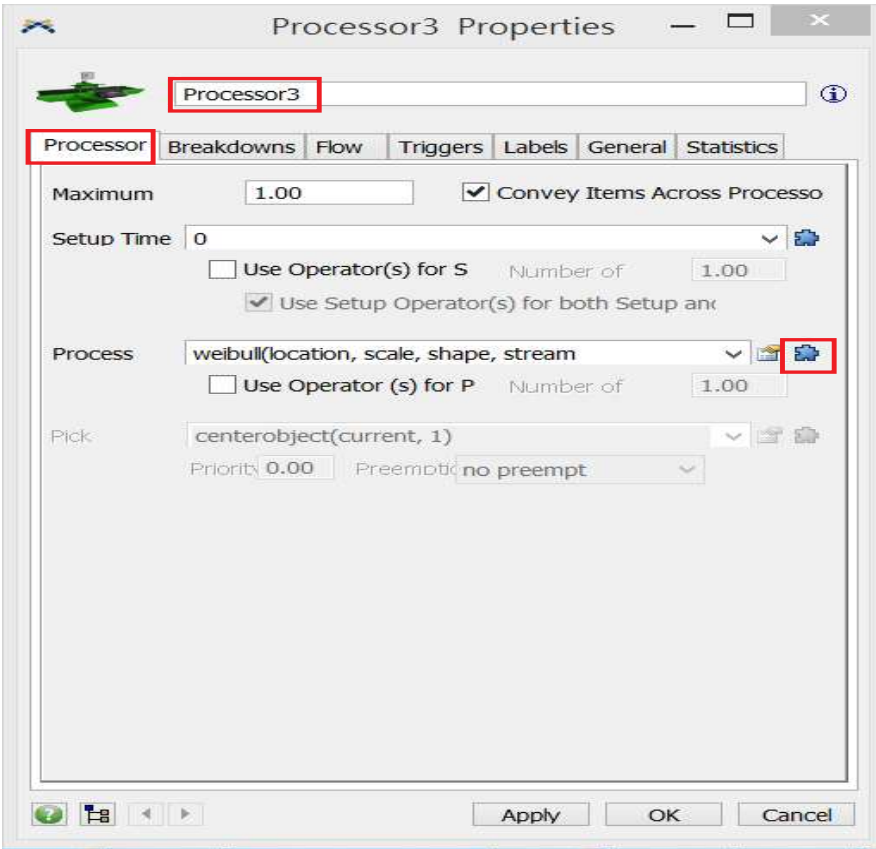
Record Time Leaving Queue

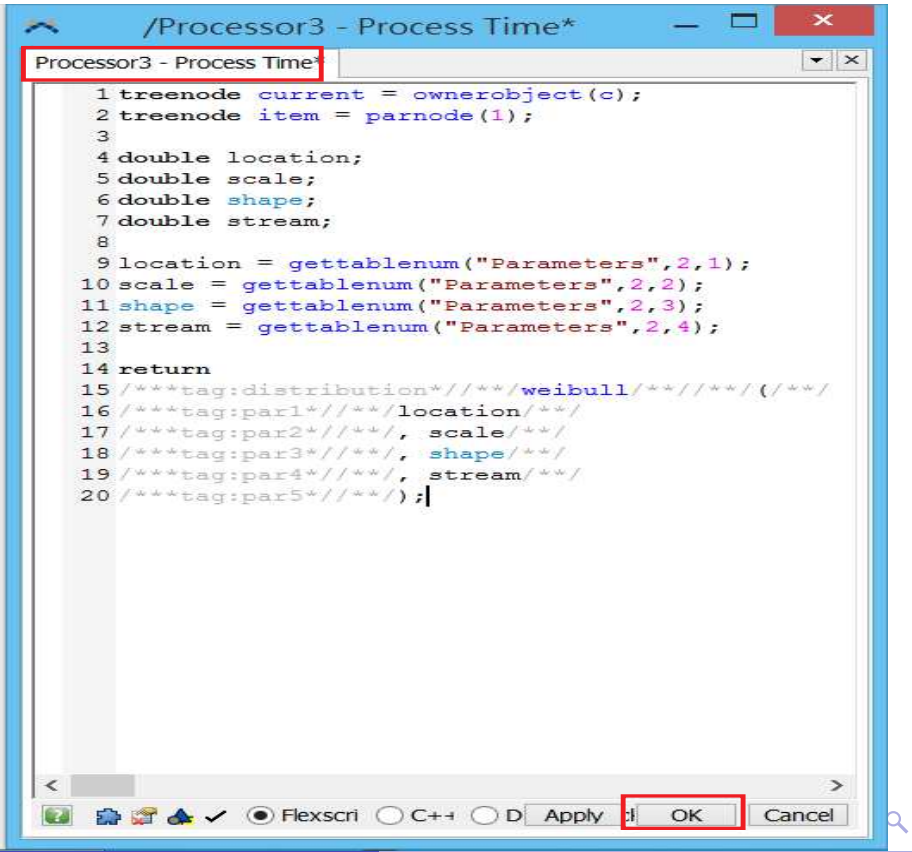
- setlablenum (item, "left_queue_time", time())



Generate Service Times

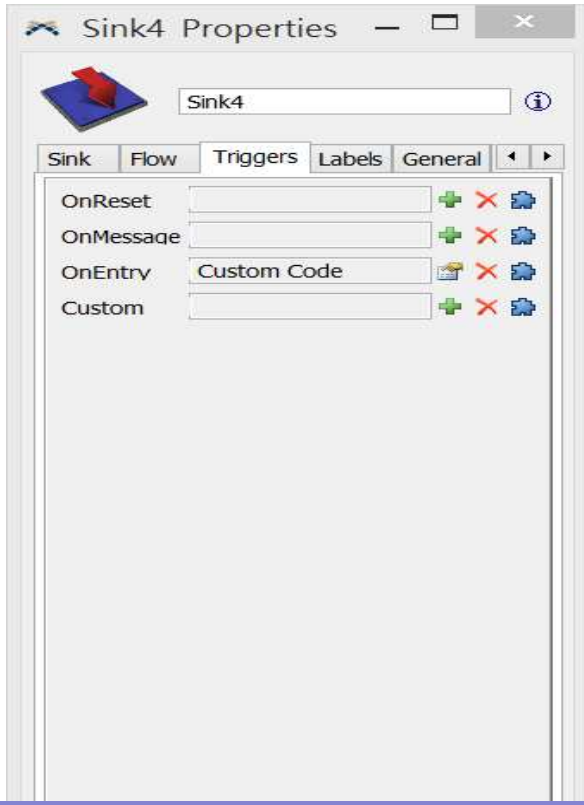
- Weibull with parameters location, scale, and shape
- Parameters are stored in Global Tables

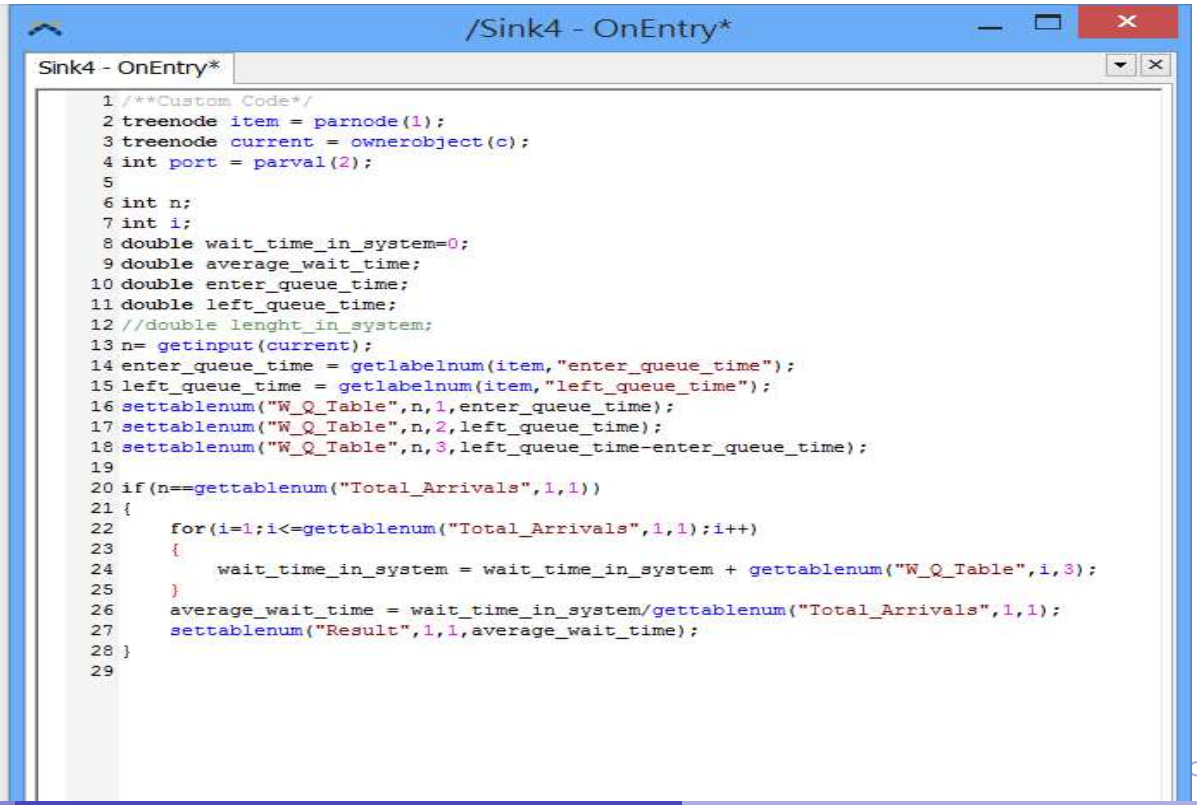




Record W_Q

- Sink > Trigger > OnEntry
- n= getinput(current)
- getlabelnum(item, "enter_queue_time");
- settablenum("W_Q_Table", n,1, enter_queue_time)



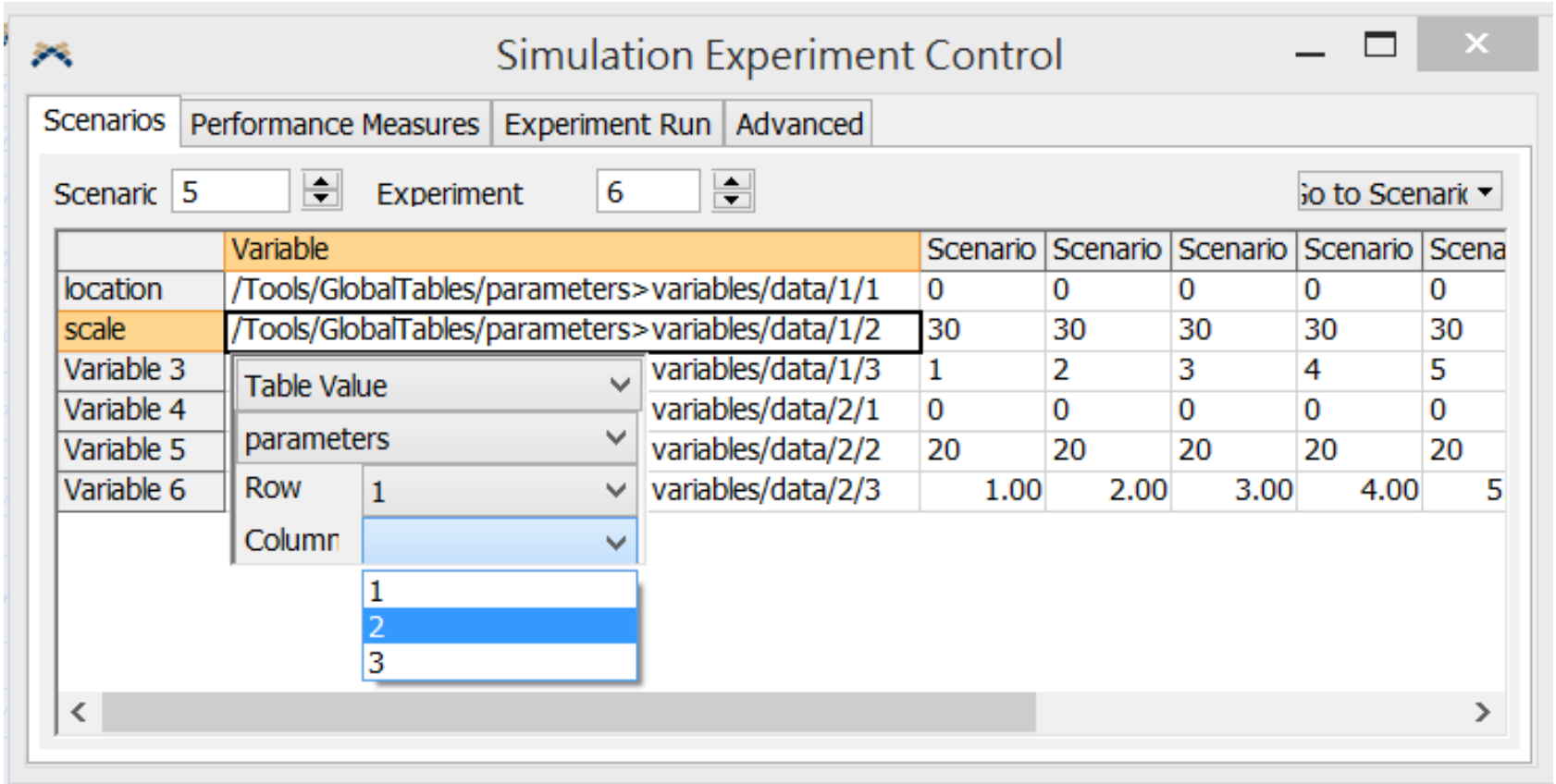



```
1  /**Custom Code*/
2  treenode item = parnode(1);
3  treenode current = ownerobject(c);
4  int port = parval(2);
5
6  int n;
7  int i;
8  double wait_time_in_system=0;
9  double average_wait_time;
10 double enter_queue_time;
11 double left_queue_time;
12 //double lenght_in_system;
13 n= getinput(current);
14 enter_queue_time = getlabelnum(item,"enter_queue_time");
15 left_queue_time = getlabelnum(item,"left_queue_time");
16 settablenum("W_Q_Table",n,1,enter_queue_time);
17 settablenum("W_Q_Table",n,2,left_queue_time);
18 settablenum("W_Q_Table",n,3,left_queue_time-enter_queue_time);
19
20 if(n==gettablenum("Total_Arrivals",1,1))
21 {
22     for(i=1;i<=gettablenum("Total_Arrivals",1,1);i++)
23     {
24         wait_time_in_system = wait_time_in_system + gettablenum("W_Q_Table",i,3);
25     }
26     average_wait_time = wait_time_in_system/gettablenum("Total_Arrivals",1,1);
27     settablenum("Result",1,1,average_wait_time);
28 }
29
```

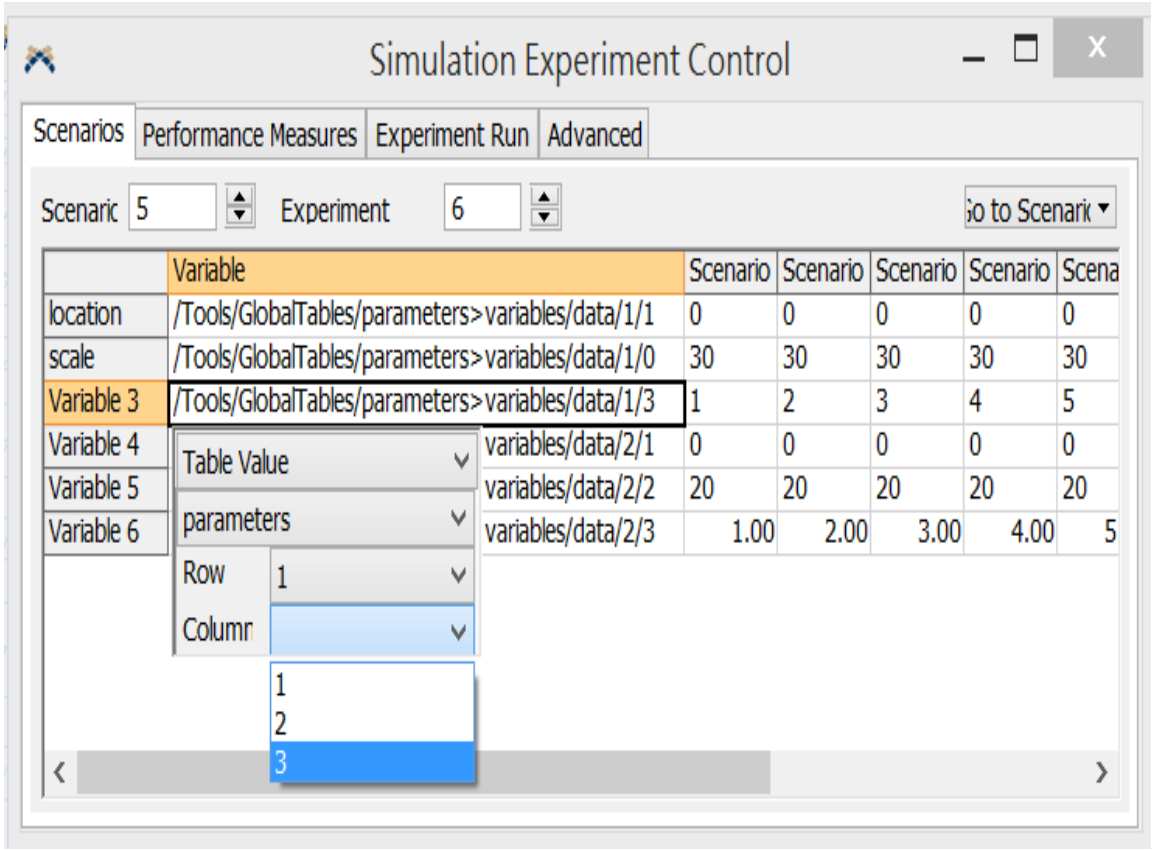
"if" and "for" Commands in Flexsim

```
if(n == gettablenum("Total_Arrivals",1,1))
{
for(i=1; i <= gettablenum("Total_Arrivals",1,1); i++)
{
wait_time_in_system = wait_time_in_system +
gettablenum("W_Q_Table",i,3);
}
average_wait_time =
wait_time_in_system/gettablenum("Total_Arrivals",1,1);
settablenum "Result",1,1,average_wait_time);
endreplication(1);
}
```

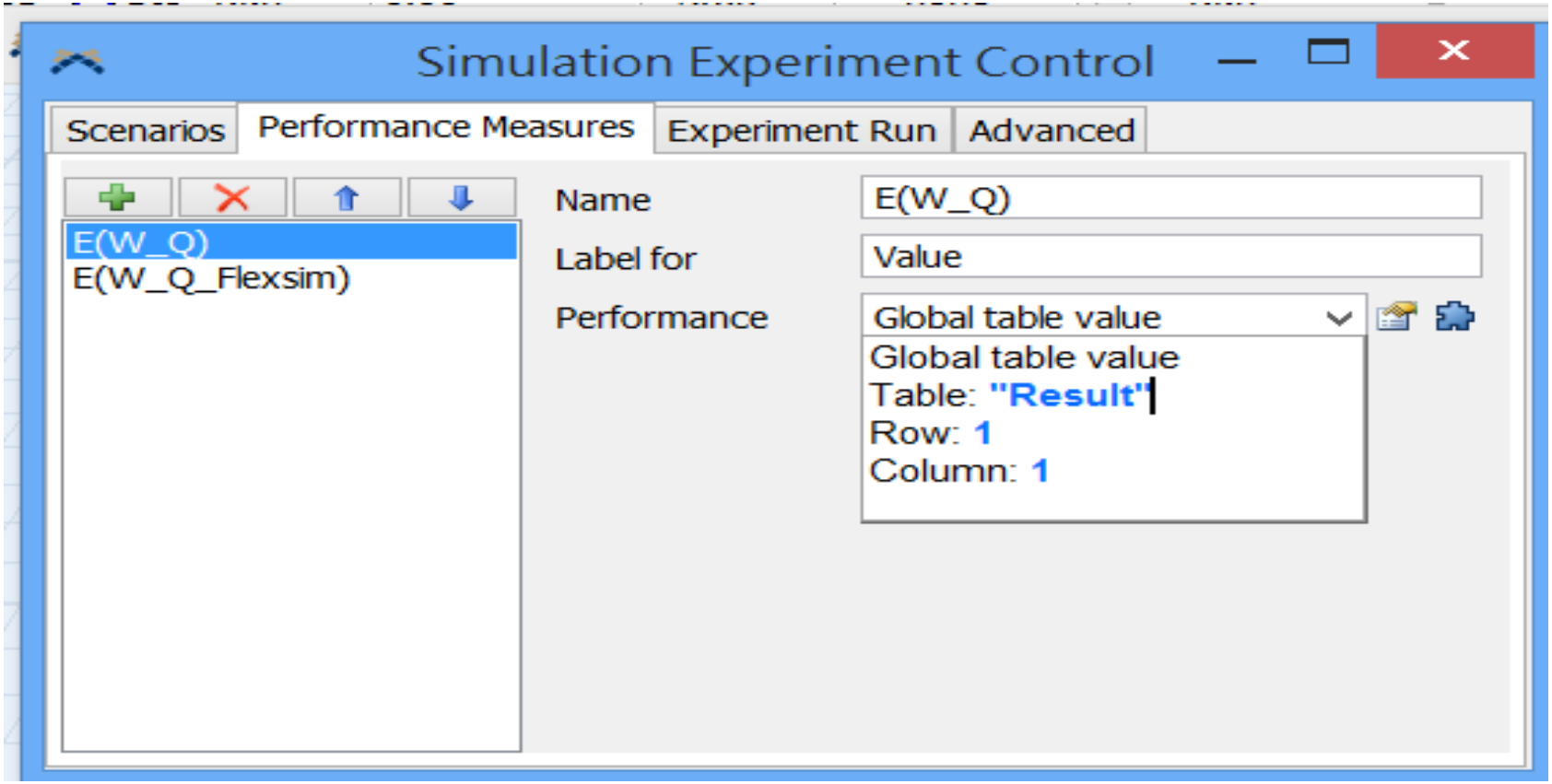
Replications



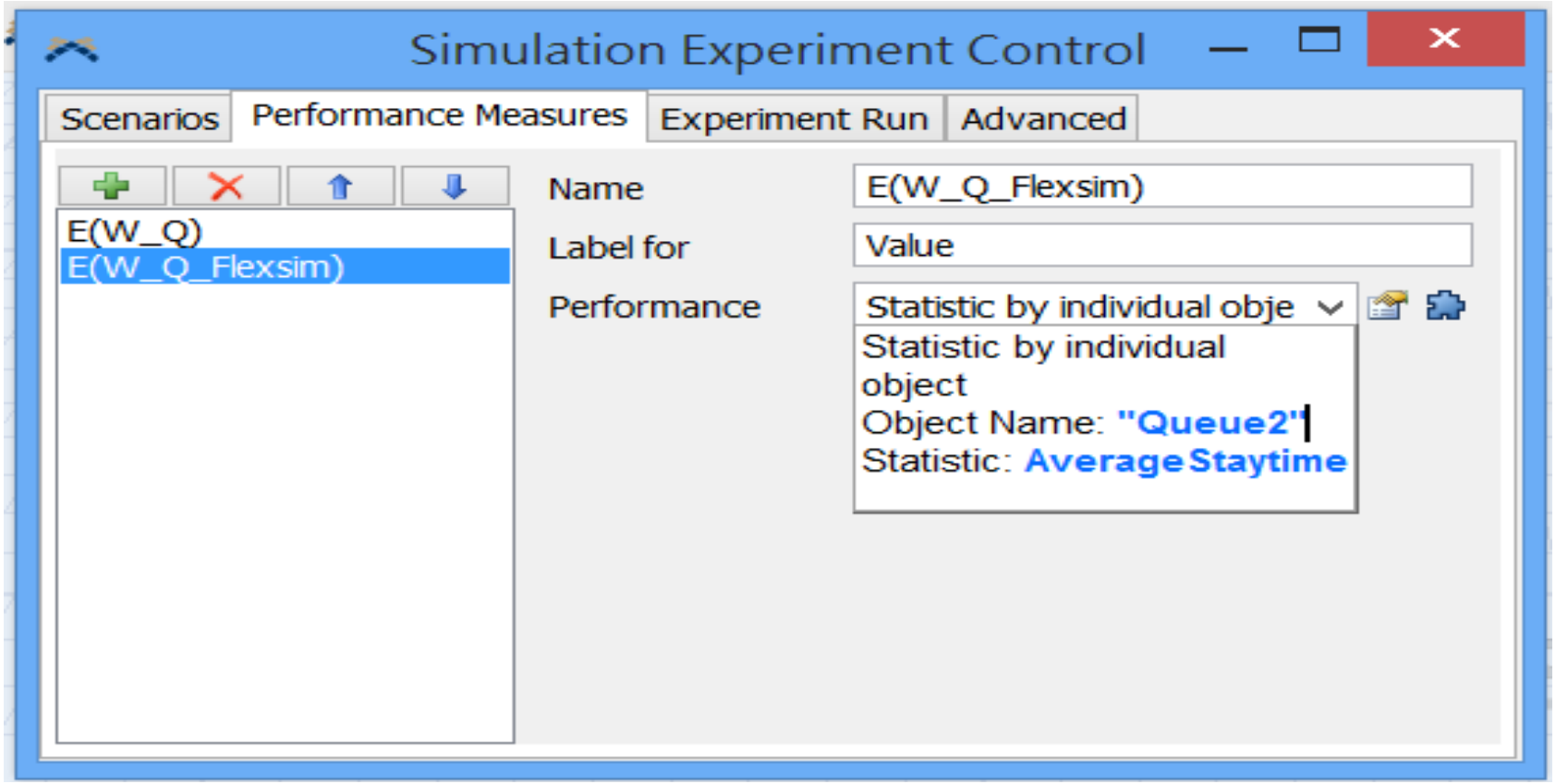
Replications



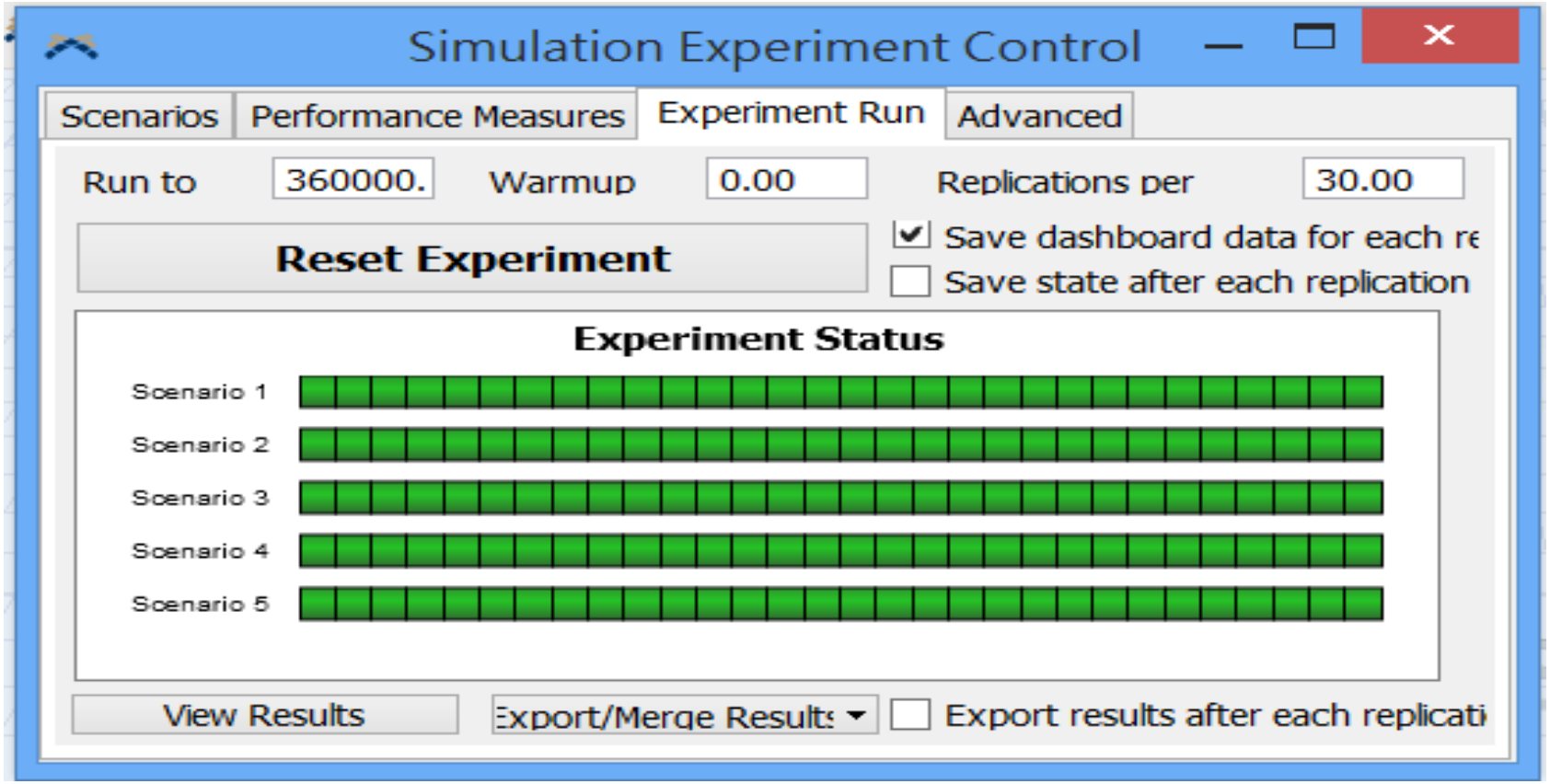
Replications



Replications



Replications



Output Analysis

E(W_Q)

Summary								
	Mean (90% Confidence)					Sample Standard Deviation	Min	Max
Scenario 1	36.78	<	40.79	<	44.79	12.91	24.03	86.27
Scenario 2	7.07	<	7.53	<	7.98	1.47	5.64	12.04
Scenario 3	2.65	<	2.76	<	2.87	0.36	2.04	3.59
Scenario 4	1.17	<	1.22	<	1.27	0.17	0.82	1.64
Scenario 5	0.58	<	0.6	<	0.63	0.08	0.41	0.74

E(W_Q_Flexsim)

Summary								
	Mean (90% Confidence)					Sample Standard Deviation	Min	Max
Scenario 1	36.78	<	40.79	<	44.79	12.91	24.03	86.27
Scenario 2	7.07	<	7.53	<	7.98	1.47	5.64	12.04
Scenario 3	2.65	<	2.76	<	2.87	0.36	2.04	3.59
Scenario 4	1.17	<	1.22	<	1.27	0.17	0.82	1.64
Scenario 5	0.58	<	0.6	<	0.63	0.08	0.41	0.74

Dependence and Correlation

C2: fx "= CORREL(A2:A1000,B2:B1000)"

	A	B	C
1	wait time in Queue(i)	wait time in Queue(i+1)	
2	0	0	0.773595224
3	0	0	
4	0	11.14	
5	11.14	0	

A

995	0	19.29	
996	19.29	0	
997	0	14.41	
998	14.41	0	
999	0	0	
1000	0	0	

Homework

- Generate time in system (rather than queue-wait-time) of M/M/1 for each customer, say $W(i), i = 1, 2, \ldots$.
- Check whether $W(i), i = 1, 2, \ldots$ are independent or dependent
- Check whether $W(i), i = 1, 2, \ldots$ follow the same distributions