Merry Go Round Project

PERFORMANCE EVALUATION OF COMPUTER SYSTEMS AND NETWORKS

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The Merry Go Round: introduction of the problem

MERRY GO ROUND → has **N** seats

Children pay one coin for a ride, and occupy a seat → Children arrive to the MGR with some interarrival time and queue up → The owner may decides to start a ride even if the MGR is not full

ride takes **T** units of time, meanwhile anyone else is taken onboard

They may decide to drop out from the queue after some threshold **Q**

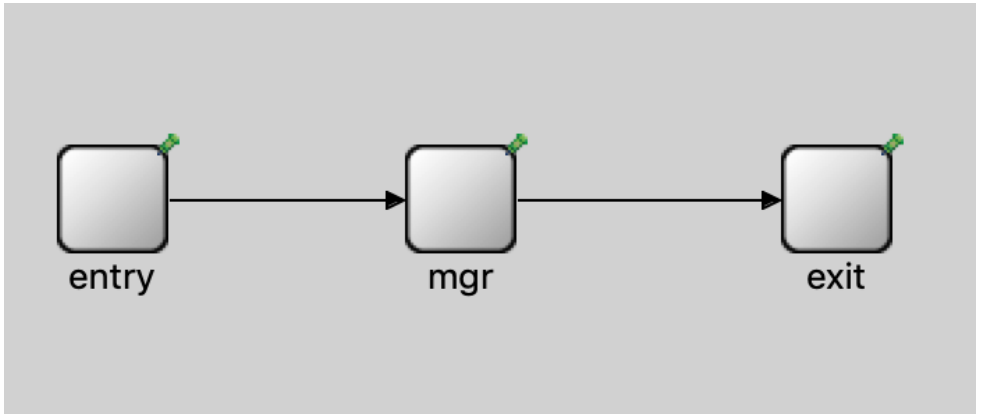
OBJECTIVES

Evaluate the earnings per unit of time

Depending on the owner's threshold and the children's patience (**Q**).

The statistic has to be evaluated in a exponential interarrival and burst (geometrical) interarrival scenarios

Modelling in Omnet++

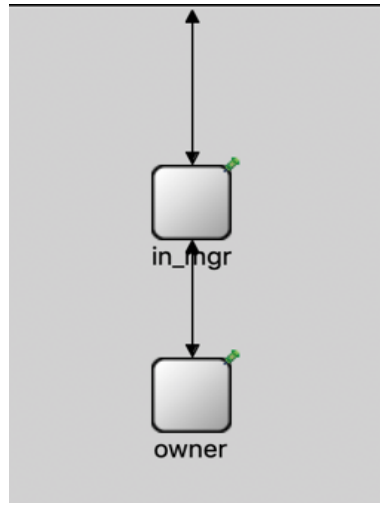


ENTRY

Responsible of generating and sending the children to the MGR both with exponential and burst interarrivals.

MGR

Compound module



IN_MGR

Queues up the children that are waiting for the MGR and those who are enjoying a ride, send notification to the Owner's module for every event

OWNER

The module responsible of taking the decision of the ride of the MGR, and collects the money.

Code analysis and factors definition

ENTRY MODULE → Children modelled as an extension of cMessage structure with a "patience" field for the threshold

Exponential interarrival → exponential(mean,rng) rng = 2

Burst arrival → geometric(p, rng) rng = 3

IN_MGR MODULE → Queues up children in a cQueue structure. → Notify the owner for every event and receives commands from him with cMessage

Periodically decrements and check for the children's threshold. If less than 0 drops the child.

OWNER MODULE → Periodically collects the earning statistic.

Money – lastmoney

With the notification from the IN_MGR, decides whether to start a ride with a cMessage notification back to IN_MGR

FACTORS

- Number of seats (N) (N=10)
- Ride time (T) (T=5s)
- Children's Threshold (Q)
- Owner's Threshold (th)
- Mean Interarrival

Validating the code and calibrating the simulator

VALIDATION

In order to validate our code we put some «stress» values in the factors to check the behavior

- **Trial 1**: QUEUE
- **Trial 2**: DROP-OUT
- **Trial 3**: EVERY CHILDREN SERVED

Money Collection

money = generatedChild – childrenInTheQueue – childrenDropped – occupiedSits

MEAN INTERARRIVAL TIME

Significant effect on the result.
Our region of interest is when the conditions holds

Mean interarrival * Sit Num ~ ride_time

Selecting a mean value different from 0,5, the result is regardless the variation of the factors

TEST DEFINITION

The purpose is to mix «low» and «high» values of both Q and owner's threshold to compare the contribution of the factors in the model

```
[Config Test1]
**.entry.Q = 2s #child patience minimum time
**.owner.threshold = 1 #owner patience minimum sits

[Config Test2]
**.entry.Q = 2s #child patience minimum time
**.owner.threshold = 10 #owner patience minimum sits

[Config Test3]
**.entry.Q = 10s #child patience minimum time
**.owner.threshold = 1 #owner patience minimum sits

[Config Test4]
**.entry.Q = 10s
**.owner.threshold = 10
```

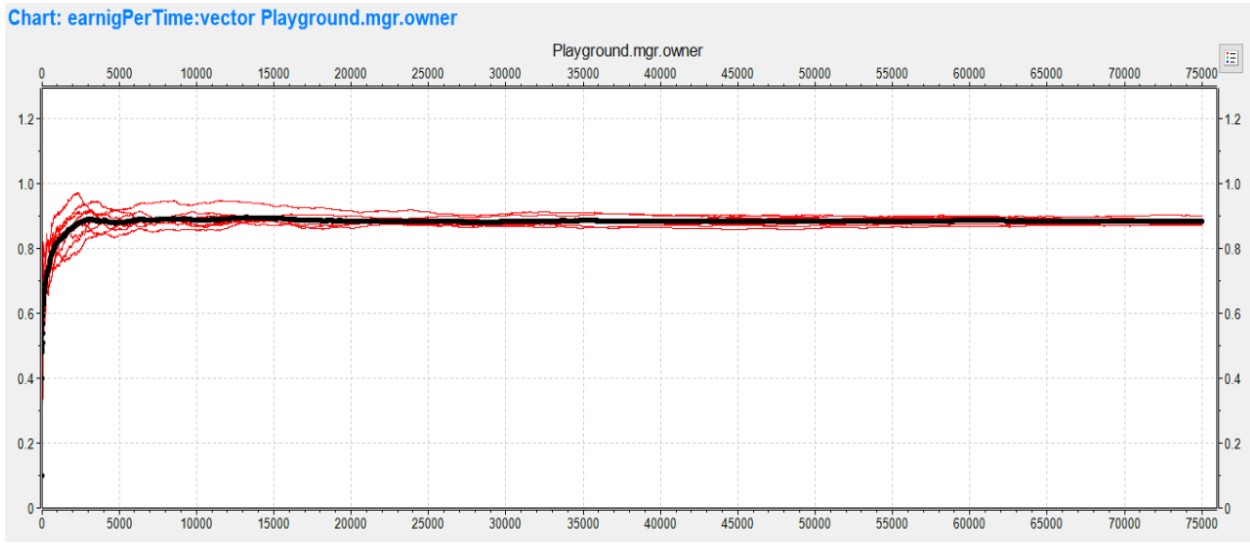
Calibrating the simulator (2)

DURATION SELECTION

duration	15000	23000	30000	38000	45000	60000	75000
Run ID							
0	0.8842	0.878	0.8764	0.8785	0.872911	0.879683	0.251033
1	0.86893	0.874826	0.8835	0.882289	0.890022	0.880367	0.249433
2	0.88527	0.878696	0.871933	0.883474	0.893667	0.88935	0.248767
3	0.92933	0.913391	0.9056	0.903763	0.900956	0.89605	0.239568
4	0.88347	0.874304	0.8694	0.865316	0.869689	0.872417	0.241434
5	0.89073	0.888217	0.900433	0.905184	0.897022	0.898983	0.236235
6	0.8884	0.872565	0.866233	0.864763	0.856978	0.86785	0.233169
7	0.89713	0.891435	0.883667	0.883684	0.877289	0.895883	0.2513
Average	0.8909	0.8839	0.8821	0.8834	0.8823	0.8851	0.2439
variance	0.0003	0.0002	0.0002	0.0002	0.0002	0.0001	0.0001
CI _ L 99%	0.8906	0.8837	0.8819	0.8831	0.8820	0.8849	0.2438
CI _ U 99%	0.8913	0.8842	0.8824	0.8836	0.8826	0.8852	0.2439

Computed sample mean and variance for every test
Test 1 is the one that shows the large variation in the result.
From the above table the best duration is 75000s because it has the least value for the variance and similar CI

WARMUP PERIOD



The above is the plot for the Test 1 case.
Values tends to get close to the aggregate in 15.000s, we select for safety 20.000s as warmup period.
Adding 75.000s duration we select a total duration of **95.000s**

Exponential Interarrival Analysis (1)

Data collection for the earning per unit of time for every test with 8 different RunIDs

configs	Test 1	Test 2	Test 3	Test 4
runs				
0	0.892654	0.251033	1.918118	1.924943
1	0.888042	0.249433	1.92809	1.932676
2	0.894707	0.248767	1.92813	1.926276
3	0.87451	0.239568	1.920331	1.92641
4	0.880523	0.241434	1.921317	1.927076
5	0.894147	0.236235	1.92625	1.925343
6	0.871124	0.233169	1.916478	1.923077
7	0.881243	0.2513	1.92729	1.933076
average	0.885	0.244	1.923	1.927
variance	0.000	0.000	0.000	0.000
StDev	0.009	0.007	0.005	0.004
CI L 99%	0.874	0.235	1.918	1.923
CI U 99%	0.895	0.252	1.929	1.932

Impact analysis of changing the owner minimum sit and child min patience values and the interplay between the two

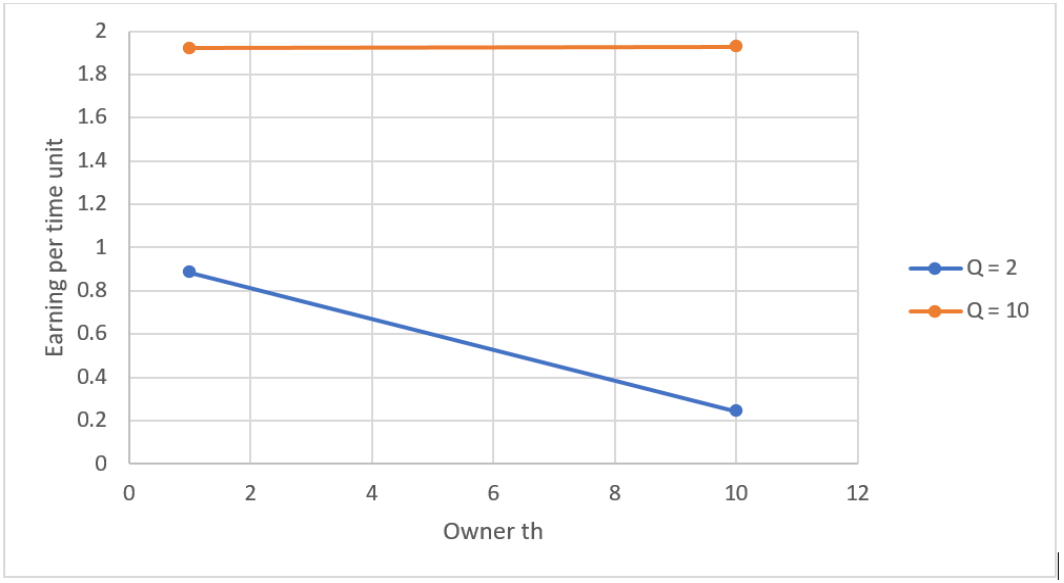
		-1	1
		owner th sit	
	Child pat. Sec	1	10
-1	2	0.8846187	0.243867
1	10	1.9232502	1.92736

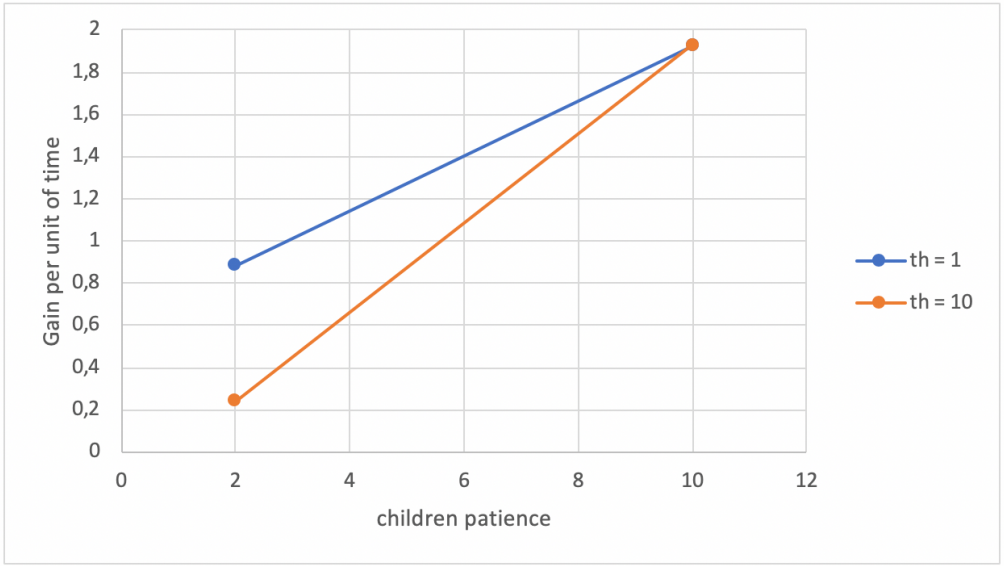
I	O th	Chi pat Q	both	earning	(Ei - E')
1	-1	-1	1	0.8846	0.130
1	1	-1	-1	0.2439	1.002
1	-1	1	-1	1.9233	0.460
1	1	1	1	1.9274	0.466
4.979096	-0.636642	2.722124	0.644861	sum of ys	2.058
1.24	-0.16	0.68	0.16	qi=total/4	
4*qi~2	0.101	1.852	0.104		
percentage	4.924	90.024	5.052		

The 90% of the increase due to children patience and the owner minimum sit threshold is nearly equal to the combine effect of both factors witch is 5%. The –ve @-0.16 indicates decremental effect.

Exponential InterArrival Analysis (2)

Plots for fixed values of both children's patience and owner's threshold





High children patience → Impact of the owner with his threshold has insignificant effect

Low children patience → The earning can be kept high by decreasing the min sit threshold

Earning almost equal → Minum patience of 10 seconds

Earning diverges → patience goes down from 10s to 2s, low th decreases wiht small rate

Burst InterArrival Analysis (1)

Given the same load as the exponential case. We collected the statistic for the same 4 tests as before

configs	Test 1	Test 2	Test 3	Test 4
runs				
0	0,822717	0,586988	1,81878	1,80193
1	0,826836	0,584589	1,82096	1,80857
2	0,837102	0,579536	1,82662	1,81072
3	0,837742	0,565391	1,81612	1,81439
4	0,825117	0,572724	1,81392	1,80636
5	0,825277	0,580323	1,81448	1,80108
6	0,823144	0,580589	1,81400	1,80383
7	0,82365	0,569791	1,81420	1,80251
average	0,828	0,577	1,817	1,806
variance	0,000	0,000	0,000	0,000
StDev	0,006	0,007	0,005	0,005
CI L 99%	0,820	0,569	1,812	1,801
CI U 99%	0,835	0,586	1,823	1,812

Impact analysis of changing the owner's minimum sit and child's min patience values and the interplay between the two

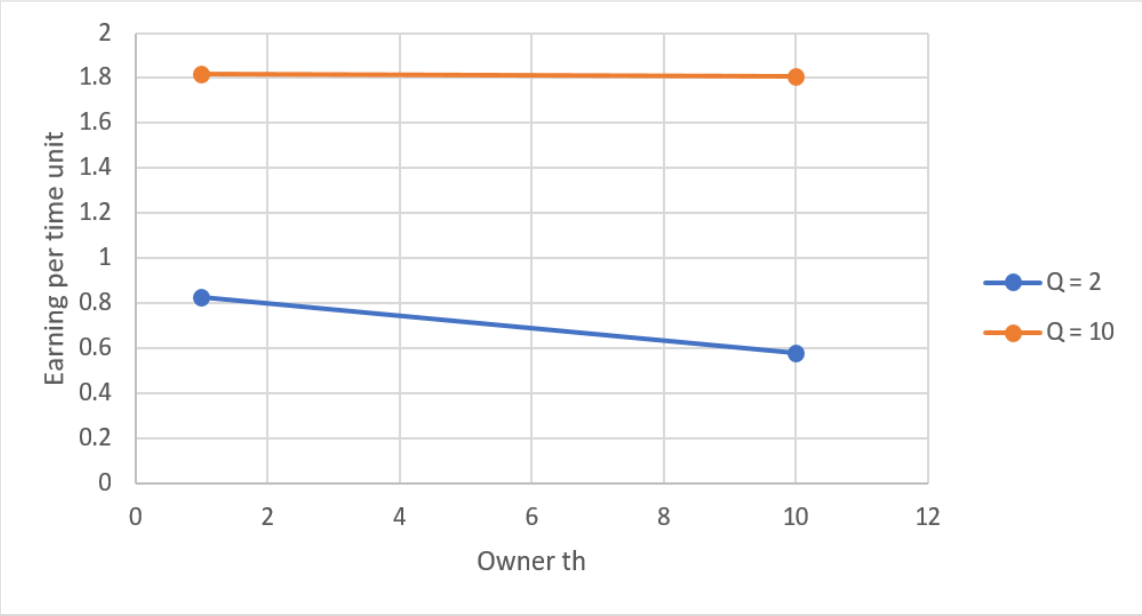
		-1	1
		owner th st	
	Child pat. Sec	1	10
-1	2	0,828	0,577
1	10	1,817	1,806

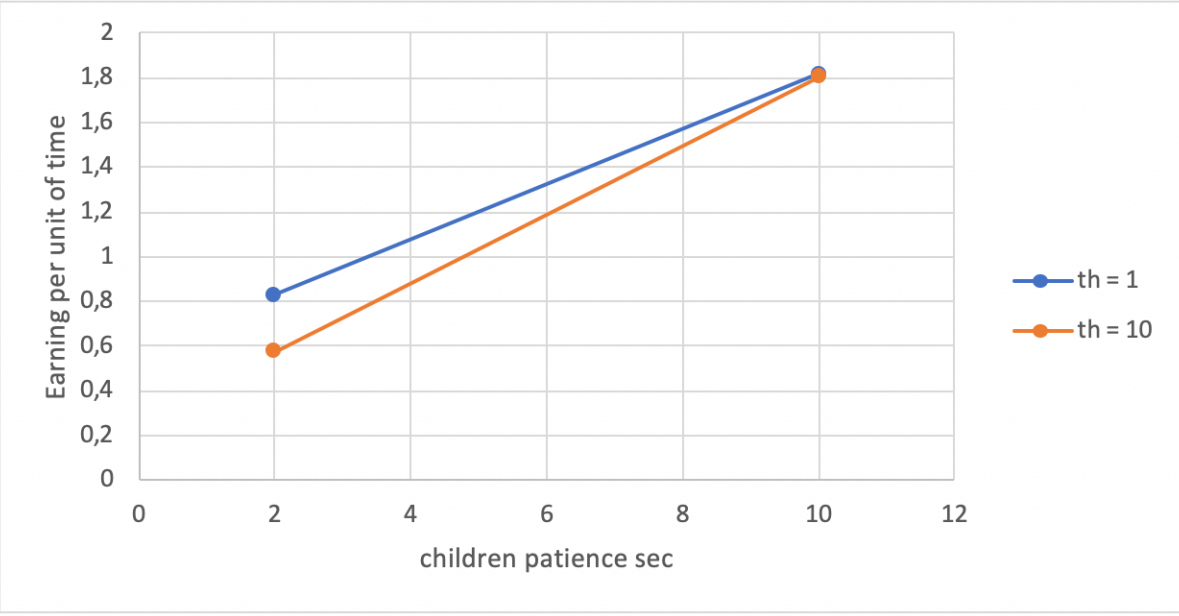
I	O th	Chi pat Q	both	earning	(Ei - E')
1	-1	-1	1	0,827698	0,184
1	1	-1	-1	0,577491	0,462
1	-1	1	-1	1,817384	0,314
1	1	1	1	1,806173	0,301
5,02874625	-0,2614185	2,218367	0,238995	sum of ys	1,262
1,26	-0,07	0,55	0,06	qi=total/4	
4*qi~2	0,017	1,230	0,014		
percentage	1,354	97,514	1,132		

The 97% of the variation is due to children patience and the owner's threshold has a 1,3% impact, similar to the combined factors. Also the –ve @-0.07 indicates opposite effect

Burst InterArrival Analysis (2)

Plots for fixed values of both children's patience and owner's threshold





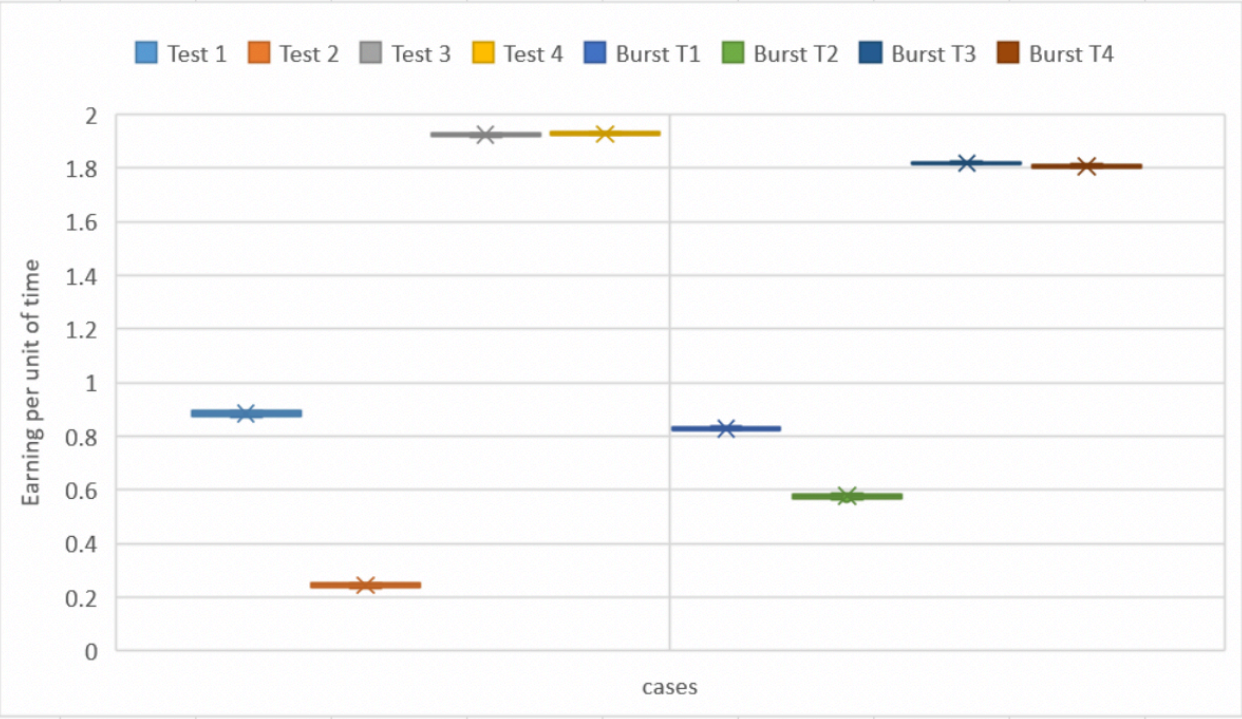
Owner has slight impact → When Q=2. The earning decreases when th increases

Owner has no consequence → When Q=10

Earning almost equal → Ow th fixed to 10 and 1 and Q = 10 at high patience

Earning diverges → When the children's patience decreases to 2s

Comparison and Conclusion



The above plot shows the range of values for the four test cases become narrower in burst arrival cases in comparison to individual arrival

Low owner sit threshold

High sit number and patience threshold

→ **"individual > burst"** from the earnings point of view

Low children patience and higher sit threshold → **"burst > individual"** in earning.

Burst arrival = exponential arrival with some arrivals with interarrival time of 0sec. => small waiting time for a child in the queue

For lower patience of children → **Recommended to decrease the minimum sit number threshold for either cases**

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Thank You!