CS1913 Project3 Report

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ABSTRACT

This report will introduce how to use java to simulate a local bank branch system, and eventually improve the perception of customer service

INTRODUCTION

General Goal:

Improve the perception of customer service by reducing the number of customers who become frustrated in teller lines due to excessive waiting

Specific Goals:

1. How many tellers to have on duty for various customer loads
2. Have a line (queue) form in front of EACH of the tellers or have a SINGLE line (queue) with each teller serving the person at the front of the single line
3. An express teller for customers wishing to make short transactions or not

Restrictions:

1. The bank has physical capacity for up to 8 tellers
2. Not having more tellers than necessary

Information:

1. Customers arrive to transact teller business somewhat randomly, but average one arrival every, say, 30 seconds
10% of the time: 75% above average arrival interval (30 + .75 * 30)
20% of the time: 50% above average arrival interval (30 + .50 * 30)
20% of the time: 20% above average arrival interval (30 + .20 * 30)
20% of the time: 20% below average arrival interval (30 - .20 * 30)
20% of the time: 50% below average arrival interval (30 - .50 * 30)
10% of the time: 75% below average arrival interval (30 - .75 * 30)
2. The average length of time it takes to service a customer is distributed as follows: {45, 70, 100, 100, 190, 190, 190, 190, 240, 250, 420, 500}
3. If an express line is available, it will be used by customers with transaction times of 45 seconds.
4. Customers get frustrated if they have to wait more than 7.3 minutes (438 seconds) to begin being served.
5. Assume that a customer goes to the line with the fewest number of people

THEORIES

How many tellers to have on duty for various customer loads?

Based on the information given, the average arrival time is 30 seconds, and the average service time is 207 seconds. Thus 7 tellers will guarantee that, for however long time goes, the length of the queue(s) will not increase with time, so called equilibrium.

The same theory applies to various customer loads also. For example, if there is a customer each 40 seconds, and it takes 207 seconds for each customer on average, 6 tellers will be sufficient since $40\text{sec} \cdot 6 = 240\text{sec} > 207\text{sec}$.

Have a line (queue) form in front of EACH of the tellers or have a SINGLE line (queue) with each teller serving the person at the front of the single line?

Based on the fact that customers go to the line with fewest people when multiple lines are available, not the line with least waiting time. Suppose a line appears long but contains customers with short times, and a customer picks a shorter line but with longer-time customers, this new customer may wait for over 438 seconds and gets frustrated. Therefore, a single line is more reasonable and reduces the potential customers can get frustrated.

An express teller for customers wishing to make short transactions or not?

Based on the fact that there is a customer in every 12 customers who requires 45 seconds service time, there is a new customer every 30 seconds, and an extra teller is needed for the express line. Having an express line will increase the tellers that are actually needed. More generally, if there are not too many customers who are qualified for the express line, the teller for the express line will not be working all the time. In this case, $\frac{30sec}{12} = 2.5sec < 45sec$, which causes the waste.

EXPERIMENTS

Make some assumptions on how customers with short service times (45 seconds) will choose between the regular lines and the express line when the express line appears long.

A customer will choose to go a regular line when the express line is not empty and there is a regular line (or the regular) that is empty.

The average wait time, the longest wait time, and the number of frustrated customers for each case

To show that 7 tellers makes the system equilibrium

runtime = 4320000sec(7weeks)			
sinline_noexpress_6teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	461015	225999	
teller2	459815	226454	
teller3	459897	225639	
teller4	463100	225259	
teller5	452981	226546	
teller6	460468	227059	
			99%
sinline_noexpress_7teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	1389	158	
teller2	1407	159	
teller3	1345	160	
teller4	1369	160	
teller5	1448	162	
teller6	1423	165	
teller7	1423	168	
			6.7-11.4%
sinline_noexpress_8teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	212	22	
teller2	242	25	
teller3	245	26	
teller4	242	27	
teller5	193	27	
teller6	251	28	
teller7	244	26	
teller8	278	29	
			0
runtime = 43200sec(12hours)			
sinline_noexpress_7teller			

	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	1389	158	
teller2	1407	159	
teller3	1345	160	
teller4	1369	160	
teller5	1448	162	
teller6	1423	165	
teller7	1423	168	
			0-21%

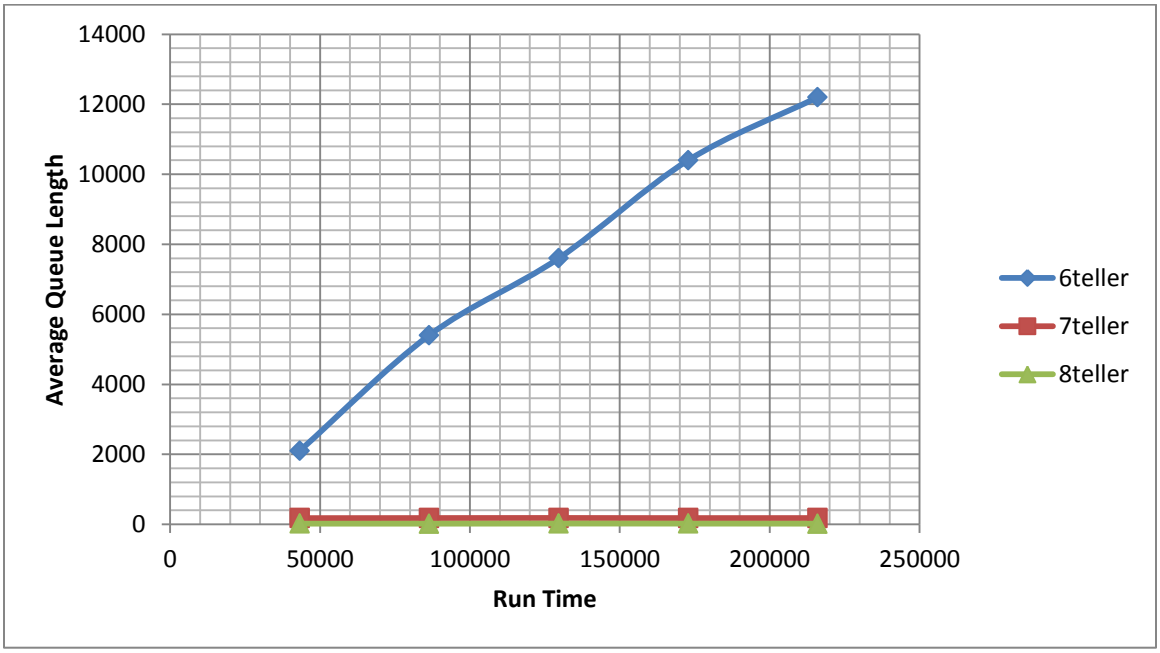
To show that single line is more stable than multiple lines

runtime = 4320000sec(7weeks)			
sinline_noexpress_7teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	1389	158	
teller2	1407	159	
teller3	1345	160	
teller4	1369	160	
teller5	1448	162	
teller6	1423	165	
teller7	1423	168	
			6.7-11.4%
mulline_noexpress_7teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	2184	304	
teller2	2276	318	
teller3	2135	294	
teller4	1972	268	
teller5	1828	230	
teller6	1640	194	
teller7	1687	155	
			17.8-23.3%

To show that an express line is a waste

runtime = 4320000sec(7weeks)			

sinline_noexpress_7teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	1389	158	
teller2	1407	159	
teller3	1345	160	
teller4	1369	160	
teller5	1448	162	
teller6	1423	165	
teller7	1423	168	
			6.7-11.4%
sinline_noexpress_7teller			
	Max Waiting Time	Ave Waiting Time	Frustrated Customers
teller1	430352	207794	
teller2	420476	208109	
teller3	420616	209740	
teller4	424729	209144	
teller5	424251	208897	
teller6	425190	208481	
express teller	60	0.9	
			99.0%



The graph shows that 7 tellers makes the system equilibrium

RESULTS

How many tellers to have on duty for various customer loads:
6 tellers: when there are very few customers, and the bank opens for very short time;
7 tellers: average waiting time reaches equilibrium, meaning will not increase with opening time. However, if the bank opens for too long, there will be many frustrated customers;
8 tellers: average waiting time reaches equilibrium, meaning will not increase with opening time. There will be no frustrated customers.

2. Have a line (queue) form in front of EACH of the tellers or have a SINGLE line (queue) with each teller serving the person at the front of the single line. Have a single line is a better algorithm than multiple lines, when the bank opens for very long time, having a single line will reduce the frustrated customers.

3. An express teller for customers wishing to make short transactions or not having an express line is a waste, especially when there are very few qualified customers for the express line, it will work like having one less teller.

CONCLUSION

To reduce the number of customers who become frustrated, have 7 tellers for usual days, 6 tellers for days with very few hours or with very few customers, 8 tellers if the bank will be open for very long time or with many customers.