CSCI 370 Stochastic Computing
Fall 2016
Proj#3: Larry's Revenge

Out: 10/29/2016@11:59:59pm
Due: Tues 12/5/2016 @ 11:59:59pm
Submission by Blackboard

30 points design (functions)
30 points (evaluation/testing)
30 points (questions)

Total 90 points

Outcomes

Upon completion of this project students will reinforce concepts covered in class concerning the Poisson Distribution in a practical example. **This assignment will require you to think very carefully about the problem description.**

The Assignment

It's the return of young Larry Lennox. A budding entrepreneur, young Larry Lennox, has decided to begin investing at an early age. To fund his future empire, Larry has decided to open a lemonade stand, selling lemonade for a fixed price per glass. As Larry's older sibling, having taken Stochastic Computing, you have decided to help Larry implement dynamic pricing (something implemented on Amazon).

Given the success of his lemonade stand open for business 2-hours per day, Larry has decided to extend the lemonade stand's hours of operations for **8-hours per day**. Larry is requesting you model his 8-hour stand to answer a few questions about the impact of dynamic pricing. Recall that, with dynamic pricing, you increase the price in proportion to the number of customers (i.e. demand) arriving each 1-hour period for which Larry's lemonade stand is open. By your scheme, the price increases in proportion to the number of customers arriving at the store. The one caveat is that if the price increases too much, it discourages customers from buying lemonade.

With dynamic pricing, you increase the price in proportion to the number of customers (i.e. demand) arriving during a 2-hour period for which Larry's lemonade stand is open. By your scheme, the price increases in proportion to the number of customers arriving at the store.

8 hours operation

Suppose the rate for customers is as follows:

- 1st hour of operation: r_1 customers per hour buy lemonade
- 2nd hour of operation: $r_2 = 1.1\ r_1$ customers per hour buy lemonade
- 3rd hour of operation: $r_3 = 1.15\ r_1$ customers per hour buy lemonade
- 4th hour of operation: $r_4 = 1.3\ r_1$ customers per hour buy lemonade
- 5th hour of operation: $r_5 = 1.45\ r_1$ customers per hour buy lemonade
- 6th hour of operation: $r_6 = 1.3\ r_1$ customers per hour buy lemonade
- 7th hour of operation: $r_7 = 1.15\ r_1$ customers per hour buy lemonade
- 8th hour of operation: $r_8 = 1.1\ r_1$ customers per hour buy lemonade

$r_1 = \lambda$

A study of customer behavior has revealed that when buying lemonade, for every 15% increase in price, you lose 10% of your customers. This means that, of the customers that visit the Larry's Lemonade during each hour, 10% of them do not buy lemonade. This happens for each of the 8 hours of operation and is a strict 15:10 proportion (e.g. a 7.5% increase in price results in 5% customer loss).

Your tasks

1. Design a flat pricing scheme of your choice for Larry's Lemonade stand and write a description of what you have designed.

2. Design a dynamic pricing scheme of your choice for Larry's Lemonade stand and write a description of what you have designed.

3. In MATLAB, using variables for your rate during each hour of operation, design a program that simulates the number of customers that arrive at Larry's Lemonade stand for each of the 8 hours of operation.

   λ

4. Using the result of task#3, design and implement code that computes the average amount of revenue empirically that Larry will make
   a. Using flat pricing
   b. Using dynamic pricing

5. Using the result of task#4, design and implement code that computes the standard deviation empirically of the amount of revenue that Larry will make.
    a. Using flat pricing
    b. Using dynamic pricing

Questions

1. Given your solutions from task#4 and task#5 above and an understanding of the summary statistics (mean and variance) for a Poisson Distribution, how do your **empirical** results for **average revenue** and **standard deviation of revenue** compare to the **theoretical** result for mean and standard deviation (square root of variance).

2. In designing a dynamic pricing scheme, at what point does the increase price pay for the lost customers. This means, at what point will you actually start taking in more money by actually discouraging customers with higher prices.

3. Is it better to employ dynamic pricing or fixed pricing? Why? It seems that the higher the dynamic pricing percent the larger the standard deviation. Flat rate daily rev changed less.

Submitting Your work

1. Prepare all of your written work and answers to questions in a single MS-Word or PDF document

2. Your assignment must be run from a two single MATLAB file
    a. FirstName_LastName_Proj3_fixed.m for your fixed pricing
    b. FirstName_LastName_Proj2_dynamic.m for your dynamic pricing

3. Make sure your MATLAB program uses API calls from the toolboxes included with the student edition. Consult MATLAB help and documentation files for guidance.

4. Include all of your MATLAB files, your data files, and your answer to the question (MS-Word or PDF) in a single Zip file (NOT rar, or 7-Zip)

1. Flat Rate pricing scheme:
Each lemonaid purchased, cost 10 $ (Hard lemonaid :-))

2. Dynamic pricing scheme:
Every 10 % increase in customers is a 5% increase in lemonaid Price or 5 cent increase.

Larry Lemonaid:

8 hours a day of opperation

rate of arrival based on hour $1 = r1 = \lambda$ (Pick an Expected Value)

Study: 15:10 ratio
15% increase in price = .15
10% decrease in sales. .1
For our model: $\$2.00 \times .15 = .30$ cents
Every .30 cent increase causes (.3) a 10% drop in sales. (.1)
Dynamic Rate limit:
30% increase in rate of arrival, causes 10% decrease in sales.

hour 2 = $1.1(r1)$
hour 3 = $1.15(r1)$
hour 4 = $1.3(r1)$
hour 5 = $1.45(r1)$
hour 6 = $1.3(r1)$
hour 7 = $1.15(r1)$
hour 8 = $1.1(r1)$

Flat Rate Pricing
\$ 2.00 a sale
Dynamic Rate Pricing
every 10% increase in customers = 5% increase in Price

Flat rate model:

$2(r1)+2(r2)+2(r3)+2(r4)+2(r5)+2(r6)+2(r7)+2(r8)$ for K many days.

$$= \sum_{i=1}^{K} 2(r1+r2+r3+r4+r5+r6+r7+r8) = \sum_{i=1}^{K}(2r1)(1.1+1.15+1.3+1.45+1.15+1.1)$$

$$= \sum_{i=1}^{K}(2\underset{r1}{\lambda})(7.4)$$

$$= \sum_{i=1}^{K}(\underset{r1}{\lambda})(14.8) \quad K = \text{days}$$

☆ Fixed Rate

Dynamic rate model:

$\lambda = r1$

decrease due to price

$$\sum_{i=1}^{K} \underset{h1}{2(r1)} + \underset{h2}{(2.10)((r1\,1.1))} + \underset{h3}{(2.10)(r1\cdot 1.15)} + \underset{h4}{(2.30)[r1(1.3)-(.1(r1(1.3)))]}$$

$$\underset{h5}{(2.40)[r1(1.45)-(r1(1.45)\cdot .1)]} + \underset{h6}{(2.30)[r1(1.3)-(.1(r1(1.3)))]} +$$

$$\underset{h7}{(2.10)(r1\cdot 1.15)} + \underset{h8}{(2.10)(r1(1.1))}$$

$$= \sum_{i=1}^{K} 2(r1) + (2.10\,r1)[(1.1+1.15+1.1+1.15)] + (2.30\,r1)[2(1.3-(1.3\times.1))]$$

$$+ (2.40\,r1)[1.45-(1.45\times.1)]$$

$$= \sum_{i=1}^{K} r1[2+(2.1(4.5))+(2.3(3.834))+(2.4(1.305))]$$

$$= \sum_{i=1}^{K} r1[2+(9.45)+(8.8182)+(3.132)]$$

$$= \sum_{i=1}^{K} r1(23.4002) \text{ for } K = \text{days}$$

☆ expected dynamic value.

rate1 = 10 (λ)

percentChange = if ((numberCustomers / r1 - 1) > .1)

numberOfCustomers = poissonrnd(λ)

decremental Percent = 0

incChange = 0

One hour Rev = price(NOC)

total Rev += day

day += OnehourRev

inc Change = floor(percentChange / .1))

if (inc Change > 3) ← replace 3 w/ 10 (price x .15)

dec Percent = floor(incChange/3) x .1

else pass

incChange = (inchange) x .05 ← replace with priceIncrement

price = price + incChange([numberCustomers - (decPercent(numberCustomers))])

else: pass

Devaluelimit

oneHoursRev = price x number of Customers.