1. (8 points) Read the article “Managing demand uncertainty: People, processes and leadership revolutionize HP media’s supply chain” by Wilkins R., Thakur-Weigold B., and Wagner S. *Industrial Engineer*. 2012 vol: 44 iss:8 pg:30. You can use Google Scholar, and then click on “Find @ GT”, or find it directly in the GT Library webpage. Answer briefly (a paragraph) the following questions:

   a. (2 points) Suppose that HP media operations have an inventory level of 6 weeks and a service level policy of 95%. According to Figure 1, depicted in this article, would they be operating efficiently? Why?

   Solution:
   No, they are not. The figures depicts an efficiency curve, i.e. the minimum amount of inventory necessary to achieve a given service level. This means that the area below the curve represents pairs (service level, inventory) that are not attainable, whereas the points above the curve are inefficient pairs. According to the figure, for a 95% service level, HP needs between 2 and 3 weeks of inventory.

   b. (2 points) What are the benefits of a “demand-pull” system from both the buyer’s and the supplier’s perspective?

   Solution:
   From the buyer’s perspective, by sending actual consumption data to the supplier for replenishment, their inventory will reflect more closely the real demand, which will help them to avoid holding too much or too little inventory for their products, so that they can increase service level and also reduce cost. From the supplier’s perspective, knowing the inventory levels allows them to plan their production and procurement activities better.

   c. (2 points) Why does HP manage different products (e.g. high vs. low revenue and gross margin products, new vs. current products) in a different way?

   Solution:
   For instance, this allows them to increase their flexibility (for instance, by increasing the buffer inventory on key products, which bring most of their revenue, while reducing the flexibility on less important products; in order to better allocate their limited resources and reduce cost while increasing revenue. Also, this differentiation allows them to manage new products, which involve more risk and uncertainty, by building product-specific offline systems that could respond to different scenarios.

   d. (2 points) How did HP improve supply chain responsiveness through a lead-time reduction?

   Solution:
   They collaborated with key suppliers that would build based on forecasts rather than purchased orders, and with this HP was able to decrease the lead-times from their suppliers and respond faster to the sales growth of successful products upstream the supply chain.
2. **(4 points)** The organizers of an annual local festival have to decide how many t-shirts with the festival logo to order this year. The cost of each t-shirt is $4 and the price to the public is $10. All the unsold t-shirts are sold to a thrift store at $1 per shirt. The organizers have kept a record of the sales during previous festivals.

   a. **(2 points)** What would be an adequate inventory model to compute the optimal order of t-shirts? Why?

   News vendor model is an adequate model. The demand is stochastic (otherwise there would not be unsold t-shirts), the problem covers a single period. Moreover there is a way of evaluate overage and underage costs.

   b. **(2 points)** Do the organizers have all the information needed to accurately compute the order size in a)? Why?

   Even though they can estimate the sales distribution from their sales data, their sales distribution would be different from the demand distribution. The demand for a given period is actually the sales plus the lost sales; so they would be underestimating the demand.

3. **(5 points)** Mrs. Smith has to decide how many apple pies to prepare for the monthly neighborhood cook-out. Each pie costs approximately $9 in ingredients and utilities. She sells each apple pie at $20. She donates all the unsold pies to a local soup kitchen. She has kept record of the demand of the pies for the last 15 months, including the times when people requested her pies but they were sold-out. Her data are shown in the table below. Her son, who is an Industrial Engineering student, offered to help her to find the optimum amount of pies she should make to maximize her expected profit. Based solely on this information, what is the optimal number of pies that her son should recommend her to make?

   **Solution:**
   We can solve this problem using the news vendor model. The overage cost is $9 since there is no salvage value. The underage cost $20-$9=$11, which is the potential lost profit of each pie. Then, under the news vendor model we find the critical ratio:

   \[ F(Q) = \frac{c_u}{c_u + c_o} = \frac{11}{9 + 11} = \frac{11}{20} = 0.55 \]

   However, we do not know the distribution of the demand. Mrs. Smith sells the entire pie, and since the sales numbers are low, we should not assume a continuous distribution and then round the result. We should use a discrete distribution. Moreover, since we just have 15 data points it is hard to show that these data fit in a known discrete distribution. We can generate an empirical distribution with the given data using the observed frequencies for each value for demand.
F(Q) = 0.55 lies between Q=4 and Q=5; however, since we assumed a discrete distribution we should use the higher value, i.e., Q=5 pies.

4. (8 points) The local farmers’ market is preparing its order of turkeys for the coming Thanksgiving Day. Each pound of turkey costs $1.5 and it is sold for $2.2 per pound. Any remaining turkeys are sold at a clearance price of $0.50 per pound. Previous years’ demand data for Thanksgiving Day are shown in the table below.

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<tbody>
<tr>
<td>Demand</td>
<td>36,059</td>
<td>43,926</td>
<td>33,823</td>
<td>39,595</td>
<td>48,726</td>
<td>44,769</td>
<td>40,829</td>
<td>39,675</td>
<td>43,831</td>
<td>28,461</td>
<td>45,727</td>
<td>46,479</td>
<td>36,213</td>
<td>45,950</td>
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</tbody>
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F(Q) = 0.55 lies between Q=4 and Q=5; however, since we assumed a discrete distribution we should use the higher value, i.e., Q=5 pies.

a. (6 points) Assume that the data above follows a normal distribution. How many pounds of turkey does the farmer market’s manager should order, such that the expected profits from this item are maximized?

Solution:
We can solve this problem using the news vendor model. The overage cost is $1.5-$0.5=$1 which is the turkey pound cost minus the clearance price. The underage cost $2.2-$1.5=$0.7, which is the potential lost profit of each pound of turkey. We get the critical ratio:

$$F(Q) = \frac{c_u}{c_u + c_o} = \frac{.7}{.7 + 1} = 0.4118$$

We are told the demand follows a Normal distribution, but we need to compute its parameters: mean and variance. If we use the given data to compute these parameters, we get that the mean $\mu=40,889.73$ and the standard deviation $\sigma=5,541.58$ (variance of 30,709,160.21). We find the standard Normal $z$ that corresponds to $F(Q)=0.4118$ and by using tables or a statistical software we find that $z=-0.22301$. Then, we find $Q= \mu + z\sigma= 40889.73 – (0.22301*5541.58) \approx 39,654$ pounds.

b. (2 points) The farmer market’s manager estimates an inventory of 9,000 pounds of turkey before the Thanksgiving shipment arrives. Taking into account this inventory, what should be the order size in pounds of turkey?
If we have starting inventory $I_0$, then we should order $\text{Max}(Q-I_0, 0)$. In this case since $Q=39,654$ pounds and $I_0=9,000$, the order should be $Q-I_0=30,654$ pounds.

5. **(5 points)** A retailer needs to calculate the number of Christmas cards to order to their supplier. Each card costs $0.35. Other costs, such as transportation and storage, are estimated to be $0.10 per card. Cards are sold for $1.5. Any unsold cards are recycled at a salvage value of $0.02 per card. The retailer estimates that the demand follows a uniform distribution with parameters 7,500 and 12,600. How many cards should the retailer order to maximize the expected profit from this item?

**Solution:**

We can solve this problem using the news vendor model. The overage cost is $(0.35+0.10)-0.02 = 0.43$ which is the total cost minus the salvage cost. The underage cost $1.5-(0.35+0.10) = 1.05$, which is the potential lost profit of each card. We get the critical ratio:

\[
F(Q) = \frac{c_u}{c_u + c_o} = \frac{1.05}{1.05 + 0.43} = 0.70946
\]

Since the demand follows a uniform distribution, we know that:

\[
F(Q) = \frac{Q - 7,500}{12,600 - 7,500} = \frac{Q - 7,500}{5,100} = 0.70946
\]

\[
\frac{Q - 7,500}{5,100} = 0.70946
\]

\[
Q = 3,618.25 + 7,500 = 11,118.2 \approx 11,118
\]

So, the order size should be $Q=11,118$ cards.