Northwestern | McCORMICK SCHOOL OF ENGINEERING

Eurogrocer: Demand Forecasting Assignment Questions

The goal of this assignment is to give you practice identifying, calculating, and weighing the costs and benefits of a predictive model in real-world practice.

Please do NOT use the Eurogrocer case questions listed on p10 of the case itself. Instead, use the following questions, which are similar, but – in your professor's opinion – slightly more appropriate for this class.

Question 1
This question is about comparing stock-outs (when customer demand was present, but items were not available) and spoilage (items that cannot be sold after their self-life has expired). On pages 6-7 of the case, you are given information about Eurogrocer's annual revenue, gross margin, and both the stock-out and spoilage rates.

A. How valuable would it be to Eurogrocer if it could completely eliminate **stock-outs**?
    - Hint: if they would have earned a 34.2% profit on 3.4% (the stock-out rate) of their $8B in revenue, then how much more profit would they have earned if there were no stock-outs?
B. How valuable would it be to Eurogrocer if it could completely eliminate **spoilage**?
    - Hint: since there was no demand for these products, this is about eliminating unnecessary costs, not foregoing unrealized profits. Note that the 5.8% stock loss on page 7 of the case refers to a percentage of total revenue.

In class, be prepared to discuss how the size of the profit margin on a good or category of goods relates to the relative cost of stock-outs versus spoilage.

Question 2
Now, let's take what you did in Question 1 and apply it to the 19 product categories in Exhibits 3(a) and 3(b). Please create **ONE table** for the 19 product categories that answers A-C, below.

A. What is the impact of stock-outs, spoilage, and the total (sum) for each product category, and the total for all categories?

In class, be prepared to identify the categories that are most and least impacted by stock-outs and spoilage, and to discuss the potential reasons why.

B. What would be the impact on profit for each category and the total for all categories if the new deep learning prediction models reduced the current prediction error by 1%?

- Hint: in this case, prediction accuracy was measured by Mean Absolute Percentage Error (MAPE), which is a measure of the percentage difference between predictions and observations. Thus, a 1% reduction in MAPE (or, error) would equal 1% of the total impact for a given category. (For instance, if the total impact of stock-outs and spoilage for a given category were $50M, then a 1% reduction in error would yield a positive impact on profit = $0.5M)

C. Given the average reduction in prediction error achieved in the pilot test, as described on page 9, what is the annual expected total and per-category impact on profit?

Question 3

Now let's turn to the costs of deep learning to predict demand. Costs are described in the case on pages 7-10, and it may be helpful to consider the cost map on page 12.

Upfront costs

Both the upfront compute infrastructure (such as acquiring or upgrading a tech stack and setting up server farms, machines, etc) and upfront data purchase / gathering (surveys, buying training data) are assumed to be $0 here. In class, be prepared to discuss whether these are reasonable assumptions. This leaves only the upfront labor cost to be determined.

A. What is the expected upfront labor cost of the IBM project team (engineers and program manager) and the Eurogrocer team (analysts and subject matter experts) to build the deep learning system?
   - Hint: Eurogrocer subject matter experts dedicate 9 hours / month – to estimate the cost of these 9 hours, feel free to make reasonable assumptions about how many hours / month a typical employee works.

Ongoing costs

The ongoing costs include fixed costs (labor) and variable costs (training and running models plus data storage)

B. What is the expected annual labor cost for the Eurogrocer team?

C. What are the excepted ongoing data costs of training, running, and storage for each product category? Please create a single table for each of the 19 product categories, specifying: 1) the number of SKU-store combinations, 2) the annual training cost for the total number of combinations in that category, 3) the annual run cost for the total number of combinations in that category, 4) the annual storage cost, and the total overall cost for each category.
   - Hint #1: the number of SKU-store combinations is simply the number of stores (500) multiplied by the average number of SKUs in that category per store.
   - Hint #2: the per-combination cost of training / running can be found by calculating the hours per combination in the pilot (page 9) and multiplying it by the cloud compute cost (page 8). You can turn this into an annual amount by noting that each combination needs to be trained every two weeks and run every day.

- Hint #3: the per-combination cost of storage can be found by calculating the storage per combination from the pilot and multiplying it by the storage cost. You will need to turn this into an annual amount as well.

Question 4
Finally, let's compare the benefits and costs.

A. Using the per-category annual benefits calculated in 2C and the per-category annual costs in 3C, create a table, showing the annual net benefit for each of the 19 product categories.
B. Do the net ongoing benefits merit the upfront costs?

And finally…
You do not need to submit anything for this question, but please come to class ready to discuss your thoughts. After being presented with all of this information, the Eurogrocer executive team decided not to pursue the IBM solution. Why do you think they made the decision they did?