2016 MSIA CASE STUDY:

PREDICTING PLANT STOCKOUTS

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PROBLEM STATEMENT

Almost any company that sells physical goods will need to carry inventory at plants and distribution centers to cover demand from internal and external customers. In an ideal world where demand, production, and transportation are perfectly predictable, a facility would carry exactly the amount of inventory required to service all shipments made in between receipts of new goods. In actuality, these factors are not perfectly predictable; this causes facilities to set inventory targets and choose a tradeoff between carrying excessive amounts of inventory and occasionally stocking out of a product.

Think about "stockouts" in a retail sense: you visit a store looking for a particular good (favorite cereal at the grocery store, iPhone at the Apple store, etc.) and the product is not available on the shelf. The same issue exists when retail locations demand product from a distribution center or plant. Stockouts can cause two problems:

- Increased transportation/procurement costs to expedite shipments
- Delaying fulfillment of a customer order, resulting in loss of revenue and/or goodwill

Both scenarios are obviously negative for the company. Predicting future stockouts can alleviate these problems.

DATASETS

Data has been collected for products at a single location (Plant A) and is divided across three files:

1. *product_details.csv* – file contains product hierarchy (subsegment, group) for product IDs (labeled 'materials') at Plant A

2. *eod_inventory.csv* – file contains end of day inventory levels for materials at Plant A; if there is a gap between days you may assume that inventory levels did not change between those days. Stockouts can be identified whenever a material's end of day inventory value is equal to 0.

3. *product_movement.csv* – file contains cumulative movements of inventory by day for each material at Plant A; there are three movement types found in the file:

    - Goods Receipt (increases inventory)

    - Ship to Customer (decreases inventory)

    - Stock Transfer (decreases inventory)

    - Note 1: These movements will not completely describe all movements of product into and out of Plant A in a given day; in reality there 54 distinct movement types, but these three make up over 90% of the total movements.

    - Note 2: The different outbound movement codes indicate flows to different types of customers (i.e. internal vs. external), but we are given no information on how to prioritize these different types. All outgoing flows should thus be treated the same.

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DELIVERABLES

First, scope the problem. Use descriptive analytics to select material(s), group(s), subsegment(s), and/or date(s) where you would like to focus. Explain why you chose this for your proof of concept.

Second, develop an analytical business case for using supervised or unsupervised learning on the datasets in a novel way to predict stockouts. We recognize that there are a number of different solutions and approaches to this problem -- be strategic about picking one approach and executing your solution from start to finish on the technical side.

Finally, summarize your results, providing the following as deliverables:

1. 15 minute high-level presentation on scope, business case, and results
2. Your presentation should include **one** visualization slide tying together the key takeaways of your results (e.g. a Tableau dashboard, D3 visualization, R or python plots, etc.)
3. Any code you wish to submit (including comments where appropriate).

    a. R, Python, SQL, and Tableau are the preferred tools
    b. If you use Tableau & wish to submit the workbook, include the .twbx file as part of your “code” package.

On the day of your interview, you will start with your 15 minute presentation, and then go through a Q&A/whiteboarding session with your interviewers. Questions may cover your chosen methodology, evaluation metrics of model effectiveness/accuracy, what additional datasets you wish you had to develop your case further, whiteboarding other approaches you’ve thought about but didn’t have time to execute, and/or discussing a modified scenario.

HINTS

Assuming that the candidate does not have experience working with inventory, the following hints may be useful in developing a strategy:

1. This is not a traditional supply chain case study. You are not expected to research inventory optimization or safety stock formulae. Standard ERP systems such as SAP will predict stockouts simply by looking at current inventory vs. expected receipts and expected demand over a given time horizon; this may be good background on how your case is typically approached in the supply chain setting. Use your own analytical skillset to propose a new way to solve the problem.
2. The obvious approach when you see a time element in the data is to use traditional time series techniques -- we are looking for a more creative use of features and models to solve the problem. Think about how you can use the time element beyond univariate forecasting methods, how your three datasets can be used together, and don't be afraid to use unsupervised learning or advanced predictive methods to formulate your solution. If you need to subset the data in any way or remove some products from consideration to implement a more interesting model, feel free to do so and explain your thought process.
3. This case is a lot of ground to cover in 5-10 hours, and the work could even be developed into a multi-week project. Remember to prioritize what can and can't be accomplished in that timeframe, and come prepared to have a discussion through both. This isn't a competition for the best results possible (though you should have some evaluation metric for your final result). Rather, think of it as an evaluation of your overall process, and a discussion on how you would approach it further/differently if given more time.
4. This dataset comes from a real Opex Analytics project for a consumer packaged goods manufacturer based in the United States. CPG companies typically do not have quick reaction times and thus do not require pinpoint forecasts; telling a plant manager that they will stock out sometime in the next 2-4 weeks is far more useful than telling them they will stock out tomorrow.