Improve Forecasts Using Machine Learning

Machine Learning has recently matured to the point that is very practical to use for Supply Chain Planning. The barriers for adoption are lowered to the point that the value proposition for even a small project will bring large gains. The challenge is to cut through the hype and understand where and how to best apply this technology to provide value to your company. When ML is used to supplement traditional statistical forecasting algorithms, companies experience increases in Forecast accuracy at the product, location, week level of 10 percent or more. We present in this white paper the background to get you started.

The first thing to recognize is that the volatility in supply chains for the past couple of years will continue. Waiting to start using Machine Learning to help solve supply chain problems until things calm down is like waiting to take medicine when you have a chronic illness. The patient, your supply chain, will deteriorate unless action is taken.

There are so many factors that are impacting supply chains that even the steady running products of the past have become volatile. Covid and other interruptions have warped demand patterns and made it hard to use historical data. Supply shortages have impacted the ability to ship orders further impacting the ability to use available data to predict the future. Where it used to be that planners had to manually plan a small percent of the product portfolio, now they need to manually intervene for nearly all the products. There is data collected from Sales, Customers, and Marketing along with industry data that planners can use, but the volume of data and rate of change has become overwhelming. Since the rate of change has accelerated it is more important than ever to increase and extend outward the data being analyzed. The adequacy of old methods of planning are proving to be more and more questionable.

Understanding ML and How it can help

Many publications and marketing materials say "use AI/ML to solve your supply chain problems", but those broad statements do not translate to actionable steps. That statement is like saying "using the power tools in your garage will make you more productive than using hand tools". Like the cordless drill in your garage ML Regression Trees are very powerful and can be used in many ways to

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help make predictions in your supply chain. You just need to know what it is and when to pick it up and use it. A little bit of background and then some specific recommendations will get you on your way to the benefits of Machine Learning for Demand and Supply Planning.

How Machine Learning is Different

Basically, Machine Learning helps to decide what data is important and how it should be used to make decisions. In traditional systems, decision making works as shown in figure 1.

Traditional Algorithms (Fig 1)

Input Data	Defined Logic	Output Data
Design team picks data	Design team codes logic	Output data based on logic

The system (spreadsheet or any other application) takes the input data and produces the output results in the same way until the users beg for an update to the logic. The logic is based on the human understanding of the problem at the moment the requirements were written for the system. Examples are: use "Sales Forecast for the first month, then planner forecast for months 2 to 12; or use Marketing Forecast for adding an amount for promotions, and new products." The problem is that even if the logic was good when it was designed, Covid happens, supply shortages hit, people change along with the quality of their predictions, and the logic that was coded as a one size fits all algorithm for all Business units, Customer Groups, Channels, time of year, etc., becomes obsolete before it is even deployed.

What Machine Learning does differently is it uses historical data and statistical relationships to create the logic (see figure 2). As the data changes the logic improves. When a significant deviation is detected in the model variables, the system performs a self-modification of the assumptions, to update the model, resulting in more accurate predictions and prescriptions.
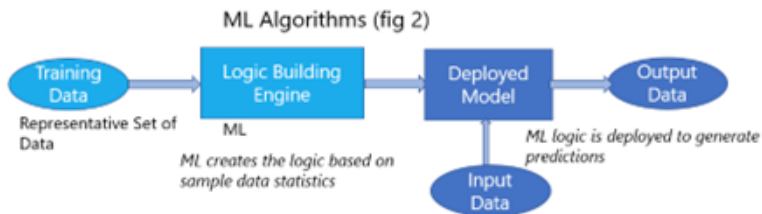
ML Algorithms (fig 2)

The best ML algorithm (power tool) to do this job for the most common problems for supply chain planning is in the category of "supervised learning." ML Regression Trees won the "Super Bowl" of Statistical Forecasting competitions (M5 Competition) this year for the type of problems that are of concern for Supply Chain Planning. Having that tool in the tool box now will help manage the volatility and changes that impact supply chains today.

To this end, a self-correcting supply chain is constantly evaluating and justifying the accuracy of the model to ensure very high fidelity to the true current values.

Making ML Easy to Use
Most of the time consumed for implementing machine

learning involves structuring and cleaning the data (data needs to be transformed from readily available inputs to ML ready), and then providing an easy way to use the process in a production environment. If the problem you want to solve fits the following very common description, a standard versatile implementation of the tool can be readily used. When a significant deviation is detected in the model variables, the system performs a self-modification of the assumptions, to update the model, resulting in more accurate predictions and prescriptions.

• The data you are trying to predict (e.g. Demand Forecast, or Supply availability) has historical data in the past (shipments or supply receipts, requested or actual).

• There are other historical data streams that may have had an impact on the predictions in the past. We may also have knowledge of what it will be in the future. (open orders, POS sales, Housing starts, etc, can you predict the weather?).

• There are Events that happened that may or may not have impacted past and we may know when they are happening in the future (COVID anyone, Price drops, stock outs, etc)

• Use of attributes that describe the class of products that we are trying to plan so that we can group similar products when building our decision trees.

Because many supply chain planning problems have the above 4 characteristics, we can use a standard formulation of ML to do the hard work for your planners. That is provide a way to capture, clean, run the algorithm, and enable people to interact with the answers. Instead of building a new solution, companies can benefit from a standard approach that responds to new situations and keeps improving itself.

Common Use Case
There are different ways the common ML formulation described above can be applied to the forecasting problem in your company for both Demand and Supply problems. There is one very common need that many companies have that fits the formulation really well, amongst so many others. Consider the following scenario depicted in Figure 3 below.
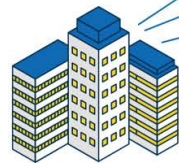
Multi Tier Demand Planning & ML (fig 3)

ML Determines which data streams drive Accurate Forecasts

Direct Channel Data
- Shipments
- Open Orders
- Stat Fcst
- Sales Forecast
- Customer Fcst
- Planner

Determine Revenue Fcst

POS Data

OEM_C @Mfg

Direct Channel

Direct ROM

Disti Channel

Disti_1

Disti_2

OEM_C @Jabil

OEM_C @Celistica

OEM_H @Jabil

Disti ROM

Disti Sell-In Data
- Shipments
- Open Orders
- Stat Fcst
- Sales Forecast
- Planner
- Sell-in Customer Fcst
- Sell-in Calculated

Determine Revenue Fcst

Disti Sell-Thru Data
- Shipments
- Stat Fcst
- Sales Forecast
- Customer Fcst
- Mktg/Planner Fcst

Determine non-Rev Fcst

In a typical extended supply chain, there are multiple data streams available that can be used to predict the needed "Revenue" generating shipments forecast. ML can determine which to use in order to generate the most accurate predictions. Some are internal to the enterprise (open orders, sales forecast, historical shipments, events, marketing input, etc.) and other data can be collected from outside the Enterprise and used (customer forecasts, POS sales, Disti sales, inventory levels, industry data, etc.).

But remember what we said was different about Machine Learning. Instead of having rigid logic in place to decide what the forecast should be, why not put ML to work to discover what logic is most likely to give you the right forecast for each different situation. That logic is automatically updated as the impact of each factor changes through time based on statistically proven correlations.

Now you know how to start with "**intelligent**" planning!!!

To get started with applying Machine Learning to your supply chain today send your request to info@adexa.com. I am William Green, wgreen@adexa.com.

Learn more at www.adexa.com.

Let's make **accurate** plans together!