A Story About a Man and a Dog

A QAD DynaSys Leadership White Paper

Supply Chain Planning and Machine Learning Industry

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SUPPLY CHAIN PLANNING AND MACHINE LEARNING

INTRODUCTION

Over 100 years ago Mark Twain was quoted as saying “A lie will travel half way around the world while the truth is still putting its shoes on”. Fast forward to the current world of social-media-connected citizens and this statement sounds blatantly obvious; but it would not have been as apparent a century ago. In a similar way, Warren Bennis was famously quoted in 1991 as predicting “the factory of the future will have just two employees; one man and one dog. The man will be there to feed the dog. The dog will be there to keep the man from touching the equipment.” Fast forward to today and this is reality.

Artificial Intelligence has been around in various forms ever since English mathematician Alan Turing gave a lecture on the subject in 1947. But its immersion into daily life has rapidly accelerated in recent years and we all surreptitiously benefit. Think about the last time you accepted a suggested Netflix movie, Spotify music, or Amazon purchase. Regardless of whether you accepted or rejected the suggestion, the machine now knows a little bit more about you.

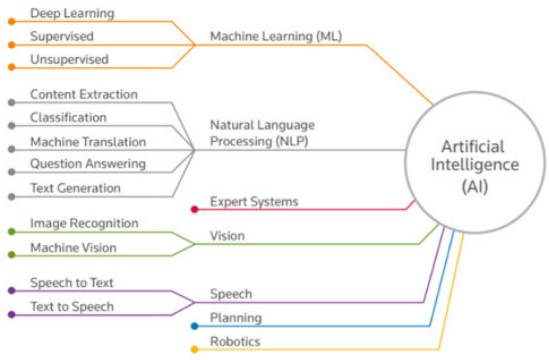
Away from solving first world problems such as which movie to stream, the adoption of Artificial Intelligence plays a vital role in society. For example, a study published by NVIDIA[1] showed that the adoption of machine learning techniques drops error rate for breast cancer diagnoses by 85%.

WHY IS THIS HAPPENING NOW?

A rapid acceleration in technology evolution began in 2007 with the nexus of three forces. These are the major advancements in Storage, Processing, and Communications. 2007 is the year of the first Android OS, the first iPhone, and the emergence of Facebook, LinkedIn, and Twitter. This all happened around the same time because of this interconnection of innovation providing an abundance of high capacity, super-fast, and inexpensive storage, processing, and communications. There are many technological advances that underpin 2007 but it was this significant step-change in the evolution curve that gave us the ability to realize the power of AI into our daily lives. From 2007 to 2017 each of these forces grew exponentially, taking the adoption of AI based solutions from science fiction to lounge room.

AI AND SUPPLY CHAIN PLANNING

AI can be a super-cool topic when discussing friendly robots, drones, and driverless cars. However it’s applicability in enterprise technology, and especially in supply chain planning is less alluring, albeit equally as valuable. There are many facets to AI, each that have varying degrees of value to enterprise technology. Robotics, drones, and autonomous vehicles have an apparent value to manufacturing and logistics but unfortunately this is often the extent of the supply chain / AI discussion



As illustrated, Artificial Intelligence comes in many flavours. Each of these bring a diverse set of potential capabilities to supply chain planning.

SUPPLY CHAIN PLANNING AND MACHINE LEARNING

Supply Chain Planning involves identifying and resolving future demand and supply balancing problems equipped with large amount of historic and real-time data, of which only some is of a “decision grade” quality. The data is ever increasing in volume and complexity. There are key trends to identify. There are predictions to make. There are tasks to automate. There are outliers to examine. There are exceptions to initiate action. There is no end to the type of critical questions in supply chain planning. How much will I sell? How much effective capacity will I have? How long will it take to deliver? What will be the results of a new product launch? The importance of a timely and accurate response is critical to business continuity. This is where Machine Learning comes to play.

There are several varieties of Machine Learning; Supervised, Unsupervised, and Deep Learning. Each with different approaches and outputs, and therefore different applicability to solving supply chain planning problems. Supervised techniques uses input data of a known structure and is used to predict outcomes and classifications of new data. Unsupervised learning makes no assumptions about the input data and is used to find clusters or unknown structures within the data. Deep learning analyses the input data to build learnings (neural networks) which are then used to make decisions about other data. Neural networks are logical constructions which ask a series of true/false questions of every piece of data which pass through them, and classify it according to the answers received.

THREE CASES IN POINT

There are many natural applications for both supervised and unsupervised Machine Learning adoption within the supply chain planning spectrum. A clear one is Product Cluster Analysis.

CLUSTER ANALYSIS

Product Clustering is a method widely adopted to plan at an aggregated product level (a cluster). Using clustering improves plan accuracy (at the aggregate level) and reduces the planning effort. When product clustering is used in demand planning, the output is often a time phased demand plan for the aggregate level which can subsequently be used to plan capacity and materials; and reconcile with revenue and profit targets. However the selection of the product attribute(s) to use as the reference points for clustering may be quite arbitrary such as Brand, Pack-Size, or Financial Category. These examples often bear no correlation to the products sales behaviour, raw material requirements, capacity consumption, planning decision lead-time, and profit and revenue contributions. Of course there are too many dimensions of a product to easily assess how a specific product should be clustered. The puzzle is difficult to gauge at just a single point in time as the goal-posts are continually changing. The sales behaviour of products change over their life-cycle; new products are launched and older ones are decommissioned. Product Clustering is not only limited to Demand Planning. It can be equally valuable in Product Portfolio Management, Supply Planning, and Sales & Operations Planning. The application of unsupervised machine learning concepts to Product Clustering significantly improves the planning accuracy and simplicity across large product portfolios.

NEW PRODUCT LAUNCH

An extension of the Product Clustering concept is the application of Machine Learning concepts to predict the performance of a product launch. What sales volumes and which sales profile will a totally new product have? Product portfolio volumes have increased significantly; especially

within the supply chains of consumer goods. Product lifecycles have become shorter and the accurate planning of product introductions, supersessions, and decommissioning is vital to business continuity despite the increased complexity.

Within an industry domain there exists volumes of data about market size and trends, competitive product behaviour, and marketing channel effectiveness. Within an enterprise there exists volumes of data about existing product behaviour, marketing spend, and product portfolio attributes (brand, price, pack-size, colour, organic, fat, sugar, salt content). Machine learning is able to analyse such volumes of data more efficiently and accurately than is humanly possible. It identifies correlation and causation which subsequently predicts a sales volume and a sales profile that determines the demand for the initial pipe-fill and the honey-moon period. This drastically improves the forecast accuracy and reduces the risk associated with product launches. Successful product launches drive revenue and higher margins.

MAKE-TO-ORDER COMPONENT PLANNING

Machine Learning is providing a major benefit in the planning of materials in make/configure-to-order supply chain environments. A major issue when planning material requirements in make/configure-to-order (MTO/CTO) environments is that the precise material requirements for a MTO/CTO item is only known within the customer order horizon, which is often only a few days. A demand forecast for the finished MTO/CTO item is usually suitable for capacity planning and budget reconciliation, however is unable to be used for material requirements planning. Traditionally this is resolved using two methods. First by using an average bill-of-materials (BOM) which averages the consumption of components based on historical usage. Secondly by decoupling the finished item from the components, and then generating a component consumption forecast that is independent of the finished item forecast. Both methods are less than ideal. The first is not sensitive to trends within consumption. The second requires additional forecasting and does not lend itself easily to manage any known market intelligence (i.e. promotional activity), nor is it conducive to forecast consumption logic and demand sensing methods.

Machine Learning not only predicts the future demand of the MTO/CTO item but it can predict the corresponding BOM. It not only look at trends (growth or decline, peaks and troughs) of individual components, it also considers time-phased inter-product relationships. For example: If the order comes from the “West-Coast region” during “Summer”, and includes the product “TABLE” with the option “ROUND LEGS”, then it will most likely have the option “WHITE TOP”. This will allow manufacturers of MTO/CTO products to have the correct stock of the correct component and the correct time. This benefit will reduce component stock and wastage, improve customer service, and reduce expedited freight.

SO WHERE DOES ONE START?

Starting out on a machine learning journey is very different to traditional software development cycles. To begin with, machine learning requires copious volumes of real data. More data than any QA lab could ever reliably produce. Machine learning results are probabilistic, meaning there are degrees of right and wrong. Where these right and wrong thresholds start and stop can be subjective and need will require real-world acceptance testing. In short, engage the business.

Another important consideration on the Machine Learning journey is talent. A 2017 McKinsey Global Institute article[2] reported that the sudden uptake of interest in machine learning is overdrawing talent from a very limited pool. The top tier companies (IBM, Amazon, and Google) have made the problem worse by securing many top graduates and domain experts. This has the potential to disrupt the realisation of many other AI business initiatives. Procuring the correct AI and data science skill into the technical teams is important. However AI and data science expertise should influence many recruitment decisions, in the business teams as well as technical and IT teams.

- ✓ Highly Automated
- ✓ Hyper Responsive
- ✓ Augmented Decision Support
- ✓ Highly Analytical
- ✓ Perpetual / Real-time
- ✓ Highly Collaborative
- ✓ End-to-End

THE GLOVES COME OFF

So this leads us to consider what will Supply Chain Planning look like in a future powered with Machine Learning? Supply Chain technology has ideologically been about perfect numbers supporting perfect decision making. This has been conventionally achieved using a known set of input-data in a standard way, and the subsequent outcomes have been mostly predictable.

However now that supply chain planning is becoming empowered with machine learning, the gloves will come off. It will rapidly evolve to an automated continuous planning tool with augmented decision support for those matters that still require planner intervention.

Needless to say it will be highly automated and hyper responsive. Monthly planning cycles will morph to weeks and days, if they haven't already. Planning cycles will eventually disappear altogether bringing us to a world of perpetual planning. Machine Learning can process super large volumes of real-time data, identifying that which potentially impacts decisions. The continuous bombardment of real-time data supported decisions will invalidate existing 'snapshot' plans. Effortless, automated, intelligent and continuous re-planning will invalidate existing 'snapshot' plans.

Future supply chain planning technology will become Highly Analytical. With the evolution of augmented analytics, natural language processing, predictive and prescriptive analytics; the focus of supply chain planners and by extension supply chain technology will be to analyse scenarios and execute business transformation initiatives. Planners will then be able to concentrate more on the value add. A future Supply Chain Planner will focus on business transformation and let the machine do the math.

Supply chain planners of the future will be deal makers and brokers. Their reach will extend beyond the four walls of their enterprise into customer's customers and supplier's suppliers and third parties. The technology will need to support the communication and the collaboration required to sense and respond to threats and opportunities. Supply Chain Planners will still be a required human resource in an effective manufacturing and distribution enterprise, however the unique skills they bring to the table will be quite different. With intelligent automation it is natural that many supply chain jobs currently done by humans will become redundant. However technology over time has been proven to create more jobs than it makes obsolete[3] and there are strong reasons to suggest that AI will continue this trend.

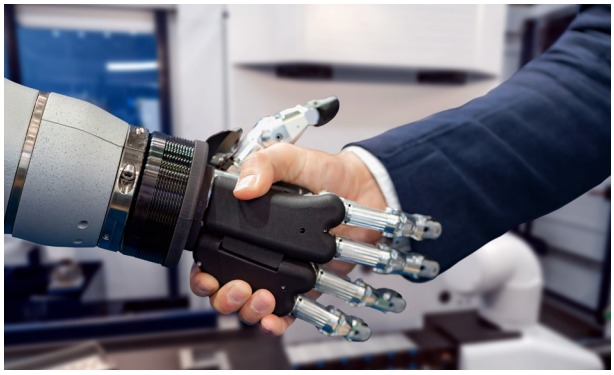
WHY IS IT BETTER

The case for adopting Machine Learning techniques is logical. It is faster, cheaper and more accurate than a human. Automation and augmented decision making makes our lives smoother. Less input for higher quality output. By nature it is probabilistic and therefore there will be outliers that will prompt us to reject a Machine Learning generated recommendation from time to time, perhaps to our peril. But this only adds to the learning. The rate of learning, the time required to learn, the measurements of what is learnt are all important as we move towards augmented business processes.

But one must remember that Machine Learning is a method to improve the execution of an existing business process. It is not a functional solution in its own right as the media hype would suggest. This may sound obvious but it is a message lost on many enterprise-software providers who rush to flaunt their AI intentions with no firm grasp on the application at hand.

THE LIMITS OF TRUST

There is still a level of trust to be established. When a diagnostic computer system detects a situation and issues an order for a remedy (your car has 20km of fuel remaining) we follow the suggested instructions without question. We have confidence in the system and the directive. But will humans react so obligingly when the suggestion comes from Artificial Intelligence instead of a diagnostic system? AI generates commands and suggestions which in some cases may appear counter-intuitive. There will be a transitional period for humans to reach that same level of confidence, especially in the areas of automated decision making where absolute control is removed. Of course this will depend upon the impact of the decision. It is infinitely easier to recover from a poor Netflix movie suggestion than the automated launching of weapons.



CONCLUSION

The adoption of machine learning in enterprise-technology is becoming the next arms-race for many vendors. Supply Chain Planning technology is currently experiencing a major step change in its evolution. The point of no-return has been reached. This is an exciting time with major benefits to be realised. Many companies sitting on a gold mine of data are set to realize it's value. The only bad machine-learning plan is no plan at all. Machine learning is a crucial part of a comprehensive digital transformation strategy.

Bennis's prediction of the factory of the future with one man and one dog is upon us. So what is left for the humans? Pure out of the box imagination is the exclusive realm of the human mind. I am sure this is what the man is doing in Bennis's story while eluding the dog.

[1] NVDIA, September 19, 2016, Tony Kontzer

[2] June 2017. McKinsey Global Institute. How artificial intelligence can deliver real value to companies

[3] June 2015: Steve Denning. The 'Jobless Future' Is A Myth

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