

# AI/MACHINE LEARNING FOR SUPPLY CHAIN

## *Into the Future*



**ChainLink Research**  
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## A New Decade

The last few years have brought a broader perspective within the supply chain community. We are now more concerned about values and global issues—not just *stuff*, its number, when and where it should be placed, and how it should be moved. Rather, we often ask our customers what their concerns are, what kind of products should we develop to support human values, and what kind of company and team *could* we be. As we spend a few moments planning how we supply chainers will respond to our changing world, it seems fitting to begin this discussion with some contemplation.

In eastern philosophy, as well as in mathematics and science, the concept of duality is extremely prominent.<sup>1</sup> Duality is living with pairs of opposites, of which both options may or may not really work for us. These are the ups and downs, the plenty vs. scarcity, and so on. Duality is considered a state of false or limited perception and to remove this we need knowledge—clarity about reality.

*This duality is supply chain management.* We live in a world of duality, constantly making trade-offs between options which often are less than satisfactory with limited information in order to move forward with *a* plan—reduce cost, but decrease service level; manufacturing OEE vs. inventory/working capital; transportation costs vs. warehouse costs; and so on.

As we enter a new decade, we also want to contemplate the future of technology. Within the media, research and consulting community, there are the usual outsized proclamations declaring the impact of the new trend or technology. In the world of AI and machine learning, we have some predictions declaring close to \$3 *trillion* of savings in 2021 (that's right now) or a bleaker picture of a sheer lack of preparedness<sup>2</sup> for the now and the future.<sup>3</sup> Though these predictions may give us a sense of security that we are on the right path or, at least, not alone, they don't provide the guidance we may need to make reality-based decisions to address our issues. Clearly, in selecting and investing in technology and process change, we want to remove duality, since so much is on the line.

In this series on AI/machine learning we have gone on a journey from [defining AI/ML for the supply chain](#) to [debunking the myths around AI/ML](#), some get-started concepts, and explored some [practical and visionary use cases](#) that organizations can apply today. But as the new decade dawns, we want to think a bit about where AI/ML is going to take us and some of the changes we may need to make now in order to *successfully* journey forward.

So, let's delve into the future of AI/ML.

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<sup>1</sup> Duality <https://en.wikipedia.org/wiki/Duality> and [https://en.wikipedia.org/wiki/Duality\\_\(mathematics\)](https://en.wikipedia.org/wiki/Duality_(mathematics))

<sup>2</sup> One white paper study declared there are approximately 10% of companies who even have some readiness to implement AI/ML with approximately another 10% who have some AI/ML, either in pilot or operation. Only a few have solid deployments. This means more than 70% of the companies have virtually no AI/ML in operation.

<sup>3</sup> If you are in software sales, this could be good news since you have a target rich environment in which to sell since AI/ML is one of the highest areas of inquiry and is rated one of the highest areas for implementation over the next four years.

## What Is Fundamental About Supply Chain Now?

Change. We all *have* to deal with it. Often, though, we are clinging to the past (seeking stability) which keeps us from seeing current things clearly.

Analytically, we might be missing definitive knowledge of what is going to happen next in the world, but we surely have a lot of questions—areas we want to explore so we can be better prepared to launch promising innovations. Two fundamentals—accepting **change** and doing **discovery**—need to form our present foundation so that we can be prepared to move forward. This seeking is where AI/ML really shines.

As supply chainers we have learned and already codified much about every little grain of data about physical inventory and its dimensions, where it can be stored, and various routes to get it to the customer. But we still have limited data about the geo-social-economic-people world.

### Change—Out with *Stable* and in with *Resilience*

We have been living through a series of dramatic economic, social, and global changes. There is no need to go into this further since it has been well written about. Suffice it to say, executives state that these dramatic swings are the “new normal,” and the challenges of globalization, where a seemingly small event in one corner of the globe can have life altering consequences for the whole planet, will continue to be the norm.

### Discovering What *Could Be*

Our views—our data—as good as they were, were actually pretty limited. So, in order to “stabilize things,” we made a lot of compromises.

*Since it was so hard to get the numbers right, many companies resorted to reducing the number of variables in the plan—that is, reducing product offering, suppliers, and triaging customer service. These were painful choices and companies always wondered what they were leaving behind.*

Today, with the Internet and the entrepreneurship it enabled, we can often see what we have been leaving behind, as frustrated and innovative consumers decide to invent a product, from socks or pet products, to face creams (see sidebar examples). The cold numbers we used just never told the whole story. Conversely, some firms relied on the “instincts” of buyers who

### Tired of the same old socks?



### New brands of socks:

ALMI  
Belaga  
Bombas  
Carartt  
Darn Tough  
Drymax  
Farm to Feet  
Feetures  
Kane 11  
Little River Sock Mill  
Rockay  
Stance  
Swiftwick  
Teko  
United by Blue  
Zensah

Private label retailers' brands have noticed and gotten into the act and developed their own brands.

Examples here:

Duluth  
Hoka  
Madewell  
Patagonia

relied on their tastes, eschewing the numbers even when they pointed to declining customer interest and sales.

That duality<sup>4</sup> again—the pure numbers game or pure creativity—probably doesn't put us on the best path to customer delight and profit.

### Changing Channel Preferences

One area that is so familiar to us now is the channel changes—some have been evolutionary and some just wrenching as shoppers moved suddenly online. And it will change again.<sup>5</sup>

Of course, ecommerce shopping continues to grow and has become the preferred channel for a growing segment of the population. Post pandemic, it is unclear if shoppers will again flock to stores or just stay home. If it can be gotten right, a much more dynamic approach to cross-channel services and allocations can save millions in inventory and transportation costs while enhancing the customer experience.

In industrial settings, having the on-site installation has stalled out due to the pandemic. This, in turn, has affected companies' abilities to accommodate the changing customer expectations of having on-site reliable and knowledgeable service personnel. Product and process designers are looking to replace some of the role of the service technician with really smart features, more remote installation capability, and/or augmented-reality, guided installation and simple repairs all done by the customer. Again, if done right, in the long run this will save an enormous amount of money in service expenses and hours of customer frustration.

These are just a few examples of what we hear across different industries. Supply chain's role in determining the future customer preference in product and service is essential. Not only will the analytic systems have to explore demand from multiple dimensions, but also develop innovative and resilient processes that can respond to most eventualities. Thus, the motivation today to see what AI/machine learning can help us discover.

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<sup>4</sup> It is interesting to note the various segments of *self-help* from publishing, health and beauty, and home appliances to food and supplements, to name of few sectors.

<sup>5</sup> Yearning to travel is intrinsic to human nature.



## Where Machine Learning Will Take Us

In the previous installment in this series we covered a range of practical and visionary use cases. In this installment, our goal is to examine what the new machine learning-enabled supply chain team should do to set the stage for now and in the future.

### Continuous Planning Through Execution

A key element of 7x24-always on business models is that the boundary between planning and execution can become superfluous—an artificial construct we had in the past due to long *information cycle times* that forced us to just make decisions and commitments with incomplete data. That commitment led to that duality again—either a building up of just-in-case inventory and/or late shipments.

Unfortunately, creative *just-in-time product* does not have a *replicator* as the manufacturer. A longer *product lead time*—and that is defined as *longer than the customer-expected fulfillment time*—means carrying *some* inventory.

As we know, not all demand is predictable and supply lines may be stymied. Helpfully, though, we are constantly getting streams of information that present opportunities for sales, optimizing supply lines, and/or reacting to dramatic events. We also need the ability to process and respond to that latest information.



We want this kind of ongoing demand and supply planning and execution to be part of the holistic processes and systems we should have already set up. We don't want to be scratching our heads at the end of the month trying to reconcile spreadsheets and emails against the actual inventory due to many changes. In other words, rather than exceptions and expedites, we want to have a *continuous process*.

In addition, if we are setting up an information system's environment that is one of perpetual learning, then our machine learning engine is always seeking out important, changing circumstances/trends or smarter ways to optimize. We want it working on the whole available data and a continuous freshening of information and actions accordingly.

*Continuous is both a system and process capability.* There is a single platform on which the demand (forecast, orders, new patterns) and supply (production and procurement) exist in the continuum, and *people are not isolated*, but work in harmony. This obviously has organizational implications. Today, many supply chain organizations are either one team or at least a matrix where, ultimately, all the personnel feel accountable to one another to deliver the total result.

As well, Chief Supply Chain Officer/VP of Supply Chain is an executive position—not tucked under finance or other functions (see later section on roles and responsibilities).

This way of working surely came in handy for many organizations as we shifted to a global, always-on, ecommerce-driven, transparent, and sustainable economy. And as the pandemic unfolded, supply chain was, de facto, *command central* to respond and adjust to the crisis for the company.

### Autonomy. What's That?

Besides continuous, another term that is being marketed in supply chain is *autonomous supply chains*. The concept in autonomy is that *the process will operate without human intervention*. This concept has created a raging debate in supply chain circles about autonomous for planning and/or execution. For companies with lots of products (and that is relative), meaning more data about your products than you can handle without computers, relying on systems to do some of the computations, analysis, and communication is already a fact. The question that you will need to answer for yourself is: *how much reliance?*

Besides one's value system or belief in whether this is desirable, there is the sheer amount of work required to achieve a totally digitized, complete, and accurate supply-chain platform. This totally digital supply chain would also ultimately include multi-tier capabilities, sensing changes and coordinating a response across multiple enterprises and service providers. One would need pretty accurate visibility of the trading partners' operations, or at least the policies and processes for an automated timely, reliable response. Practically speaking, *if* this is desirable, then it is quite a journey! And is it feasible?

What *is* feasible is the automation of many tasks that take up part of the planners' and production team's day, tasks that computers can do pretty well. After all, we do trust them with an extremely important and essential process, our ecommerce, to check for availability, take and promise most orders, and set things up for fulfillment with little—or no—human intervention.<sup>6</sup>

We are so inundated with information that we might like our systems to just get to work without constantly alerting us as they find a better path forward in, say, transportation routes, locating inventory in the network, and when to build product based on demand for highly reliable replenishment items. Again, we already do operate these types of tasks today—sometimes human orchestrated and others semi-autonomously.

After researching this topic with many supply chain professionals, going the total distance to full autonomy does not seem like the goal, *at least for now*. However, the idea that there is more to automate—better automation in information flows, data quality, identifying critical events, and recommending other solutions to optimize inventory or fulfillment is most desirable. And again, this level of automation should be part of the holistic supply chain platform.

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<sup>6</sup> Yes, years of work have gone into process and technology innovation to make this autonomous. And that is the point. It is a journey to autonomy.

## A New Systems Lifecycle

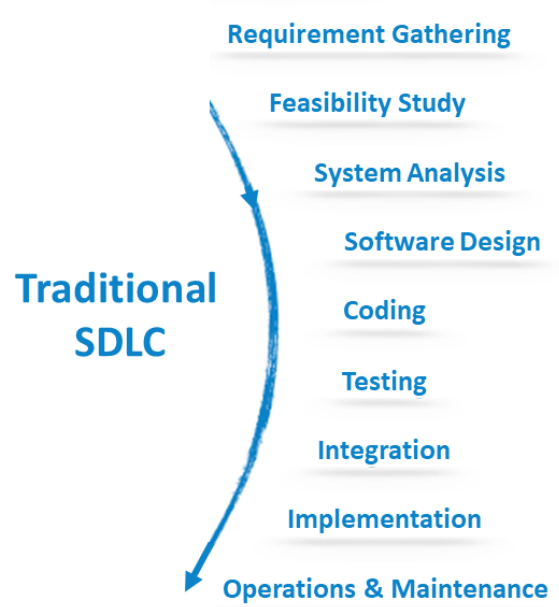
One other important area that needs change now is how we adopt new systems capabilities. AI/machine learning requires a new model (see side bar) that takes advantage of the learning environment/capabilities of the technology.

Companies are looking for more agile approaches that allow users to rapidly engage and use the solution. Agile development/implementation is especially helpful in the dynamic world where change is upon us and we need to react quickly. Agile lets users learn about and use the new technology in bite-sized, therefore, lower risk sprints.

So, what does that lifecycle look like? Figure 1 proposes such a lifecycle.

Discovery is something we often turn to analytics for. The old systems lifecycle approach leaves analytics to the end of the process, *after* the rest of the transactional or planning system has been built and a data warehouse installed to support this reporting. That's way out in the distance! One of the gems of a *machine-learning lifecycle* approach is that users can get a glimpse of those new insights as the capabilities are being created—not way down the lifecycle.

Another bright spot in the AI/ML development and implementation area is using AI/ML for data cleansing. This arduous, tedious, and time-consuming task of data acquisition and cleansing is reduced. Rather than purchasing, installing, populating and cleansing data as a precursor to even getting an opportunity to engage and use technology, we get engagement much earlier in the process.



In traditional systems implementations we identify a needed capability such as a seasonal forecast, and then select some programs from a stock list to run our forecast and inventory plan. Before we can actually implement and use the system, though, we need to acquire and cleanse data sources, often manually. In addition, there are the building, connecting feeds, running tests, and so on that occur.

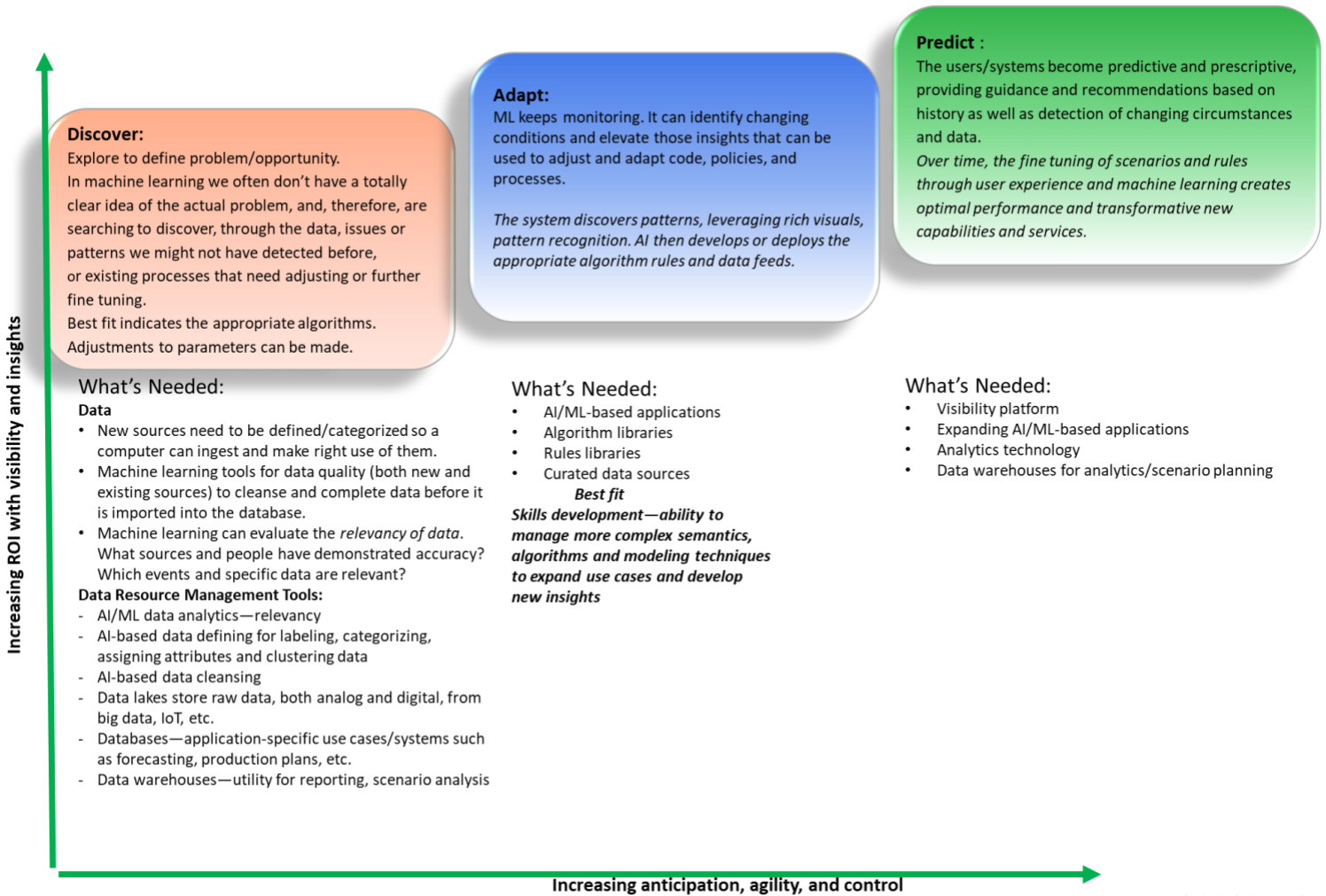
Eventually, we actually get to turn this on. Then the on-going (and perpetual) new report writing occurs.

Machine learning and Artificial Intelligence stake out a different position—creating a different process—a process of discovery and evolution—posing questions, or discovering patterns which will lead to recommended methods to solve the problem.

The ongoing state, then, is discovery/ change, change/discovery, where we are continually learning and proactive as things change around us.



## Machine Learning Project Management/Software Development to Solution



Source: ChainLink Research

Figure 1: System Adoption Process/ Lifecycle

### Changing Roles and Responsibilities

Another area that should be addressed is the roles and responsibilities of both supply chain and IT. So much is on the shoulders of supply chain pros today that they should be given the due respect and support appropriate to all they know and all they do. Many of them have deep economic, technological, statistical/mathematical, and business skills. We, therefore, call these professionals [Supply Chain Scientists](#).

With the advent of the so-called data scientist, the hunting, analyzing, and, often, categorizing of data fell into the hands of the [data scientist](#), who is by training a software engineer who knows the AI/machine learning technology. This happenstance has created some confusion, frustration, and *recreating the wheel*. The data scientist is not the business owner or the data resource manager in the organization. That work would be better placed with the “data people,” rather than the software engineer. Table One has some guidelines clarify the specific roles in a AI/ML enabled organization.

Role	What to Know
<i>Supply Chain Scientist</i>	<p>This is the business analyst/supply chain user who is interested in customers, markets, and their environments. This person knows what issues impact supply chains and the sources that can be acquired to analyze those impacts. They intuitively know the semantics about the data, and operate the system.</p> <p>Within the supply chain team, as well, users may become experts on source data, its value, and impact, for example, how weather affects demand, how trade/import/export regulations affect ocean costs and routes, and so on.</p>
<i>Data Resource Management, the Data Methodology People</i>	<p>They systematize the data about the data (the data dictionary). They know the systemic automation of data ontology and the tools: data lake, databases and the data warehouse technology best suited to serving the varying data needs.</p> <p>Due to the diversity of data and sources and the applications that might use them, we need to restructure data and enhance its definition based on these new needs. That means we are moving to a world that is beyond the manual creation of relationships in database structures. Data lakes or data fabric (two of the terms you might see) use knowledge graphs, automating the ontology, linking the various types of data stores, processes (programs), and APIs as yet another layer in the information architecture.</p>
<i>AI/Machine Learning Software Engineer aka Data Scientist</i>	<p>The data scientists code and apply machine learning platforms and technologies to search, analyze, and report. They can also automate the ontology, since that may require the use of a host of tools.<sup>7</sup></p> <p>They may also install and support the AI/ML-based applications or work in tandem with the application software expert who supports the supply chain application.</p>

**Table One—Roles in the Modern Supply Chain Team**

In addition, within the organization other pros have a role to play. The Chief IT Architect, or CTO, is responsible for the technologies and the overall map/architecture of how everything fits together. And we will still have the application-specific software expert who is responsible for the solution and, generally, knowing the business issues as well as the application depth.

It is expeditious, therefore, and *kind* to think up front about who is going to do what in the new AI/machine learning-powered organization.

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<sup>7</sup> Semantic tools: RDF, RDFS, OWL, SPARQL, SHACL, R2RML, JSON-LD, and PROV-O

## Conclusions—What If...

The term “*what if scenario*” is bantered about so much. However, maybe we didn’t stretch ourselves enough when exploring the “what if.” This could be part of the reason why so many companies were caught flat-footed by the dramas we have been subjected to recently.<sup>8</sup> And in front of our eyes, more change will definitely happen.

We have to live in our current reality and at the same time, prepare for our future. So, what should we do about this duality? In one philosophical track they advise: do what you must do, but always *be open to the possibility that things may be different in the next moment*.

How can we create more dynamism in our organization, systems and people, then, so we are prepared for a more fluid world?

- *Institutionalize discovery and change*. Though this may seem like an odd statement—to *institutionalize change*—but to continue to seek stability as the end-all won’t allow us to see what might be happening right in front of our eyes, or what we need to do next.
- *Make the processes and IT platform continuous*. Break down the artificial barriers between people, data, and how we measure success.
- *Unleash creativity*. Turn to the team for ideas on how to organize for maximum resilience and effectiveness. If we are relying on our people and partners to get it right, we better ask them to design a process where they—and we—can be successful.

Part of the challenge in the human mind and the systems we use is that they are a projection of the past moment, even AI and machine learning systems, to some degree. After all, who is developing and using these? People who rely on their points of view or historical data, which, inherently, are biased. Any bias about what happened before or lack of imagination about what could happen next stymies creativity, and we need to be creative if we are to start asking different questions.



*Seek...Discover...Listen...Change*

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<sup>8</sup> After all, there has a lot been written about risk, pandemics and so-called black swans in the last few years.



#### About ChainLink Research

ChainLink is a recognized leader in custom research and advisory services, with a focus on supply chain, Internet of Things, and blockchain. Founded in 2002, our emphasis from the start has been on inter-enterprise interactions and architectures ('the links in the chain'). We have conducted over 75 primary research projects, interviewing and surveying over 10,000 executives and professionals. Much of our research focuses on industry-specific use cases, business cases and ROI, and drivers/inhibitors of technology adoption, and business change. As a result, we have developed a deep, multi-industry practice, founded on real-world, validated, supply chain-wide, end-to-end perspectives that have helped our clients understand, plan, and succeed as they move into the future.

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