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What are the Key Drivers of Future Supply Chains?

Penina Orenstein*

Daniel Ladik†

Sean Rainford‡

Abstract

While there are many factors that can influence the direction of supply chains, we believe that there are a distinct set of emerging trends that stand to define the field and the study over the next several years. These are (a) big data giving way to fast data, (b) the advent of the social supply chain era, and (c) the rise of the knowledge workers. This paper discusses how these three broad areas are transforming the future of supply chain management both from an individual perspective, as well as, using an interrelated approach.

Keywords: supply chain management, big data, social media, knowledge workers.

I. INTRODUCTION

The concepts of big data, social media and knowledge workers are well known. The report by Davies et al. (2011), analyzed key drivers that will reshape the workers landscape and identifies six key work skills which will be needed in the next ten years. These are (a) the rise of smart machines and engines (b) new social media ecology (c) a globally connected world (d) extreme longevity (f) a computational world and (g) super-structured organizations. All these skills are viewed as inter-connecting cogs which are driving the workforce of the future. Notwithstanding extreme longevity, this research suggests a simplified structure which we consider will have a key impact on the supply chains of the future, namely big data giving rise to fast data (or (a) and (f)), social media, or (b) and (c) and knowledge workers, (g). We propose that these three motivational forces as the drivers of the supply chains of our future.

While these drivers might be considered as shaping future supply chains, what is less clear is how these drivers will shape the underlying mechanism of future supply chains. It is now commonly accepted that large sets of information will always have their place in the supply chain organization. However, the new frontier regarding data is the manner and speed in which it is analyzed. With this new means of data management and analysis, we can now telegraph trends and be better prepared to manage those shifts much more deftly.

Likewise, social media can afford the opportunity to provide feedback across all points in the supply chain which in turn can be used as business intelligence for the organization's benefit. As with all new trends and technologies, how social media is managed will ultimately determine how beneficial it will be to the organization at hand.

* Associate Professor, Department of Computing and Decision Sciences, Stillman School of Business, Seton Hall University, 400 South Orange Ave, South Orange, NJ 07079, USA. E-mail: Penina.Orenstein@shu.edu.

† Associate Professor of Marketing, Stillman School of Business, Seton Hall University, 400 South Orange Ave, South Orange, NJ 07079, USA. E-mail: Daniel.Ladik@shu.edu.

‡ MBA Candidate, Stillman School of Business, Seton Hall University, 400 South Orange Ave, South Orange, NJ 07079, USA. E-mail: Sean.Rainford@student.shu.edu.

The term “knowledge workers” is far from new. In fact, the term was coined more than five decades ago. However, the continuous wave of college educated, technologically savvy specialists who use knowledge as their primary tool of trade entering organizations is very recent and unlike anything that has been seen before.

Supply chain management is concerned with the efficient integration of suppliers, factories, warehouses and stores so that merchandise is produced and distributed in the right quantities, to the right locations and at the right time. Supply chain management can also be seen as a way to link major business processes within and across companies into a high performance business model. It follows that in order to achieve a high level of efficiency both within and across the supply chain, there is a need for highly skilled workers, large volumes of data, an ability to interpret this data, as well as transparent communication. This paper explores how each of these functions support the foundations of supply chain management. We first provide a brief overview of the stages in a typical supply chain and then explain how and to what extent each of the concepts of big data, social media, and knowledge workers contribute to these stages.

Figure 1

Stages of Supply, Production and Distribution in a Supply Chain

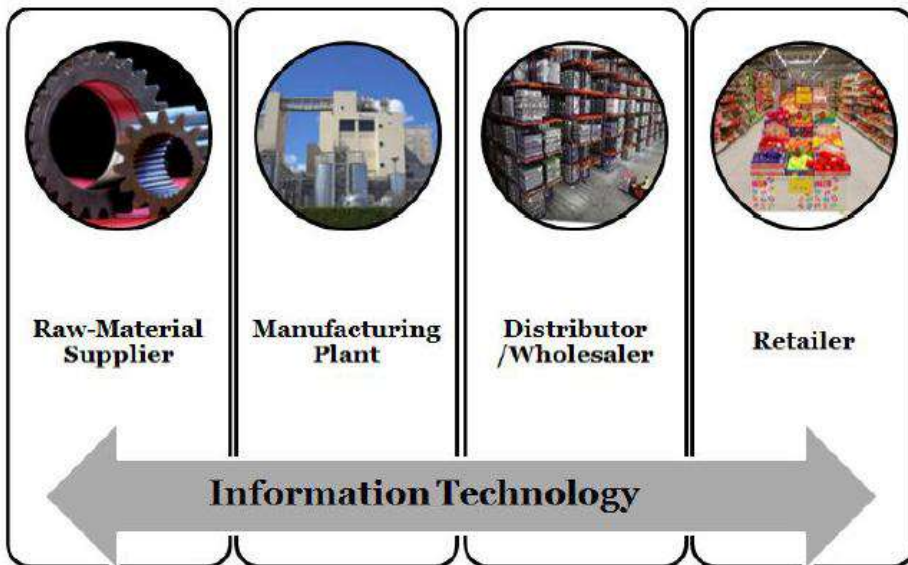
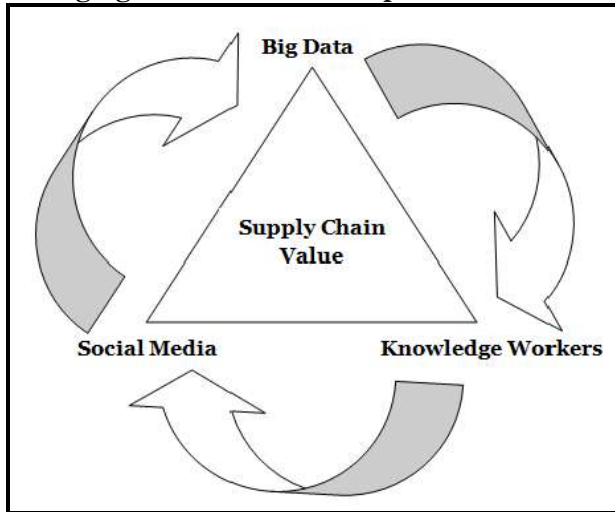


Figure 1 provides a graphical overview of the stages in a supply chain. One can observe that the transformation of raw materials into finished goods goes through the stages of supply, production, and distribution. The common thread which transforms this operation from a series of stages into a supply chain is the integration of information technology which links these processes together. In this context, information technology involves the use of systems (especially computers and telecommunications) for storing, retrieving, and sending information.

This paper examines the nature of the transfer of information from the perspective of big data, social media and knowledge workers and also determines the extent to which these three functions are in fact interrelated. We demonstrate how supply chain value emerges as a result of these three central themes (Figure 2), as well as, how they amalgamate together.

Figure 2
Emerging Trends: Relationships



II. REVIEW OF EXISTING LITERATURE

2.1. Big Data

The world's technological per-capita capacity to store information has roughly doubled every 40 months since the 1980s. Today's supply chains are surrounded by massive amounts of external data that cannot be used by traditional supply chain systems. Today's "digital universe" is expanding at a rate that doubles the data volume every two years. In addition to this exponential growth in volume, Jeseke et al. (2013), highlight two further characteristics of data which have substantially changed. Firstly, data is pouring in. The massive deployment of connected devices such as cars, smartphones, RFID readers, webcams, and sensor networks adds a huge number of autonomous data sources. Devices such as these continuously generate data streams without human intervention, increasing the velocity of data aggregation and processing. Secondly, data is extremely varied. The vast majority of newly created data stems from camera images, video and surveillance footage, blog entries, forum discussions, and e-commerce catalogs. All of these unstructured data sources contribute to a much higher variety of data types. As such, big data has risen in prominence as companies try and analyze and optimize the flood of information pouring into organizations from these multiple sources.

Big data is defined as data with a volume greater than a petabyte (one billion gigabytes) which is coupled with a growing variety of data. In 2001, Gartner defined big data in terms of velocity, variety and volume but in today's world, there is an additional requirement which is to derive value from the data explosion. Siegfried, 2014 expands on this original definition by describing big data as "data that is too large and complex in either volume, velocity or variety to be used in traditional supply chain architectures". The article continues with an important observation: "the concepts of big data supply chains will underpin most value network initiatives". It will not be about data for the sake of data, or mobile for the sake of mobile, or social data for the sake of social; instead, it will be about the convergence of these new technologies.

Traditional supply chain applications have evolved to use transactional data to improve the supply chain response. The underlying element of most supply chain

systems is order and shipment data, which has been analyzed using ERP (Enterprise Resource Planning) systems. But according to Cecere (2013), new forms of data do not always fit traditional architectures. Conventional supply chains were architected to use structured data with software using relational databases. The big data era has made many of these systems from the last decade obsolete or less applicable. In a sense, big data offers the opportunity to redefine supply chain processes from the outside-in and define the customer-centric supply chain. It is clear that not only are data volumes growing, but the velocity of data is accelerating and the variety of data is increasing. However, the challenge today is that companies cannot always use the data that they have today given the current supply chain architecture. New methods and algorithms need to be developed in order to harness the power of big data.

2.2. Social Media

Plain and simple, one of the tenets of supply chain management is to reduce inefficiencies within the supply chain and social media will be part of next wave of making the supply chain frictionless. Since this is the cutting edge, many supply chain managers are still unclear on the strategic applications of social media within the supply chain and a recent study put it well: “we know social networks will transform supply chain processes, we just don’t know how exactly, and where to start, and why” (Gonzalez, 2013, p. 16). In this study, 45 percent of the respondents said that “social networks will make supply chain processes more efficient, responsive, and cost effective” over the next five years. However, in the very same study 30 percent of the supply chain professionals indicated that their companies currently block access to social media sites. In this section, we will first define social media and second, highlight a number of areas where social media could aid in the transformation of the supply chain over the next several years.

Tuten and Solomon (2013) define social media as, “the online means of communication, conveyance, collaboration, and cultivation among interconnected and interdependent networks of people, communities, and organizations enhanced by technological capabilities and mobility” (p. 24). What is most unique about social media is that media changed from being a top-down one-way means of communication to a bottom-up multi-way means of communication. Just as important, social media communication can be synchronous (like a phone call) or asynchronous (like email).

Beyond the definition of social media, supply chain executives need to re-think their common everyday knowledge of social media. First, social media discussed in the business press such as Facebook, LinkedIn, and Twitter is mostly consumer facing and has little to no usefulness in any supply chain and logistics context. Instead of thinking about cat videos on YouTube or viral memes on Twitter, executives should think how two-way bottom-up social media can enable members of the supply chain to communicate, collaborate, and execute business processes in more efficient, scalable, and innovative ways. Simply put, social networks facilitating people-to-people communication and collaboration, is at the heart of managing and executing supply chain processes across raw material suppliers, manufacturing plants, distribution or wholesale partners and finally retailers.

For instance, delayed shipments, supply shortages, and unexpected demand spikes are just a few pain points for the supply chain executive. Social networking via social media can help companies identify and resolve exceptions faster and more effectively, especially because responding to exceptions often requires collaboration and communication between many different people, and existing approaches (back-and-

forth emails or endless conference calls) are inefficient particularly when resolving problems is cross-functional or cross-companies. For instance, GE is solving problems faster thanks to the implementation of a social networking platform called GE Colab, which enables employees to communicate and collaborate more effectively using social media across business functions, geographies, and business units. In a recent interview, Ron Utterbeck, GE's CIO for GE Corporate and the Advanced Manufacturing Software Technology Center detailed: "one in three of the connections that we have on the site are across functions. One in four is across geographies, whether between North America and Asia, Europe, South America. And one in five is across our business units" (Berkman, 2013, p. 2-3).

2.3. Knowledge Workers

Just as big data and social networking continue to get adopted by industries and factor heavily into how decisions are made and communicated, a certain subset of the working population have long utilized technology and knowledge to create immeasurable value to supply chain management. These people are the supply chain knowledge workers. These people have unlocked previously undiscovered value in the operations stream. While it is commonplace to have knowledge workers in such industries as technology, medicine, or business, few people outside of the supply chain industry would believe that knowledge workers would thrive, or even exist, in such a decidedly operations intensive industry. However, the more you look at what supply chain management constitutes, it becomes much more palatable to understand not only why and how this trend emerged, but why we have barely scratched the surface of its burgeoning potential.

Supply chain management is one of the more integral business units of an organization. Its influence spans everything from procurement purchases to people hires. A lean, efficient supply chain is a time consuming and costly exercise from both a creation standpoint and an operational standpoint. In fact, it is so much of a mental marathon that it often requires individuals equipped with not only the formal education but the experimentalist mindset to constantly reevaluate and adjust even when there seems to be no obvious need. Supply chains are a complex matrix of networks that require constant monitoring, re-evaluation, and redesign to ensure optimal performance. Furthermore, there are continuous cost pressures and an overall need for flexibility and agility in order to create a harmonious integration within its various components.

Knowledge workers are the key as they represent the very small minority of the overall labor populace equipped to handle the challenges in running an effective, efficient supply chain. By definition, their work is predicated on adding value to an existing process or service (see Figure 2). As such, the knowledge workers in the supply chain not only choose to involve themselves heavily but are often needed to be involved. Simply put, they design the supply chain, modify it when necessary, and extract value where possible.

According to Altekar (2005), "knowledge workers are required for all aspects in the supply chain ranging from transportation, warehousing, inventory management, sales and customer service. They clearly are the key to assisting the IT organization define the data and application integration requirement" (p. 392). Knowledge workers transform supply chains because they look for problems to solve rather than have the problems find them. Knowledge workers keenly understand change and variety as many of them were raised in an era in which the technology of the time offered them a

plethora of options in which to engage their abilities. They are consistently looking for new avenues and challenges to devote their time and efforts which is why they mesh so well within the supply chain arena.

It is commonly accepted within the circles of organization management that a responsive and agile supply chain is needed in order (a) to stay competitive in today's global economy, (b) generate organic growth, and (c) extract greater value from your operations. Supply chain knowledge workers are among the best equipped to handle the complexities of these operations by bringing synergy among the different stages in the chain. In addition, supply chain knowledge workers are typically the individuals at the forefront working diligently to keep the operations fluid and seamless in the face of challenging circumstances. As stated by Butcher (2007), "Supply chain knowledge workers maintain supply chain performance and improve it by compensating for inherent operational instabilities and changes in supply and demand. Hence, knowledge workers contribute to the adaptability, responsiveness, agility and resilience of supply chains."

In many ways, knowledge workers themselves are supply chains as their abilities and experiences are the raw materials that are making their way through different channels with an ultimate goal of providing value to the end-user (Figure 2). Supply chain management as a study and industry stand to continue to benefit greatly by the influx of and contributions of knowledge workers. As we progress into the new era of the supply chain knowledge worker, we can look forward to these individuals continually creating new solutions that will allow organizations to meet the ever-changing needs of its customers. Going forward, knowledge workers will stand to redefine supply chain management and extend its boundaries further into the mainstream conscious.

III. APPLICATIONS

In this section, we explore how big data, social media and knowledge workers could be used to transform the supply chains of the future.

3.1. Applications of Big Data

To apply big data analytics in a business environment implies an increase in the level of efficiency in operations. If one considers the historical perspective, information technology was a key driver to make supply chains rise in prominence (Figure 1). Big data analytics brings things to an entirely different level.

The logistics sector is ideally placed for big data. Today logistics providers manage a massive flow of goods and at the same time and create vast data sets. For millions of shipments every day, origin and destination, size, weight, content, and location are all tracked across global delivery networks. If the supply chain data streams from multiple logistics providers would be integrated, this could eliminate current market fragmentation, enabling powerful new collaboration and services (Jeseke et al., 2013).

A constraint in achieving high operational efficiency in a distribution network occurs at the "last mile" (Gonzalez, 2013). In the logistics sector, the last mile is a metaphor for the final section of a supply chain, in which goods are handed over to the recipient. This final hop in a supply chain is often the most expensive one. Some applications of big data analytics in this field include, real-time route optimization, crowd-based pickup and delivery, predictive network and capacity planning, strategic network planning (through powerful forecasting techniques), as well as, operational capacity planning (for example routing of trucks).

Another application of big data is at the retail end. Traditionally, firms in retail supply chains have used data pertaining to orders placed across echelons to make inventory-related decisions; however, mounting evidence suggests that such an approach is likely to lead to inefficiencies across supply chain echelons, for instance, by giving rise to the bullwhip effect. Companies can couple the power of predictive analytics and forecasting to ensure that a stock-out will not occur and that the online item being ordered will be available for fulfillment.

According to Barratt et al. (2015), big data analytics will require “a world of radical transparency” and enable “scalable collaboration” based on customers and suppliers allowing access to their own databases. Despite these broad assumptions, there is recognition that functional silos within organizations delay the exploitation of shared data and as such these silos must be broken down.

This effectively means that at each of the stages in the supply chain (Figure 1), there is a need not only to collect and store different types of data, but more importantly, in order to add value to the supply chain, the real challenge will be in the ability to interpret the data and use this information to improve the supply chain’s performance. This is a clear link between the functions of big data and knowledge workers.

3.2. Applications of Social Media

If we were to re-examine Figure 1, perhaps the easiest applications of social media is as an information technology to connect supply chain executives across companies. It is much easier to exchange time-sensitive information among members of the same firm (e.g., the manufacturing plant) when the key decision makers are under the same roof or use the same proprietary email system. However, if executives need to get time sensitive information to separate distributor, manufacturing, and raw material supplier firms at the same time, email or one-on-one phone calls may not be sufficiently time sensitive. Business-to-Business (B-to-B) microblogging platforms like Microsoft’s Yammer which operate much like Twitter but with a private secure network can link hundreds of executives to an urgent message via text messages sent straight to their cell phones in seconds. Similarly, MightyBell, a gated social networking platform for communities and businesses is used by American Express, The Bill & Melinda Gates Foundation, as well as, LeanIN.org; the non-profit created by Facebook COO Sheryl Sandberg aimed at helping women talk openly about challenges to achieve their goals.

Another excellent social media application is the use of Wiki platforms. Wikis are another communication platform where multiple supply chain managers could conduct an asynchronous threaded conversation to solve a problem. For instance, let’s say the retailer in Figure 1 needs to reverse-logistics shipping materials back to the manufacturing plant. The retailer could post this thread to a private Wiki and invite a number of distributor/wholesaler and manufacturing plant supply chain executives therefore creating a virtual brainstorming session. Everyone on the wiki can add or comment on a solution and all of this brainstorming occurs in a safe and secure environment where only the members invited can see the conversation. Moreover, the reverse logistics problem can be solved by the key decision makers, across firms, in a timely manner without any face-to-face meetings.

3.3. Applications of Knowledge Workers

Think of all the information that gets passed from a standard radio frequency identification (RFID) tag to its scanner about various goods being processed through the supply chain. Then, from the scanner, information from the tag is transmitted to a middleware platform for further dissemination and analysis. From there, it will be further transmitted to a central information management hub where it can be queried by other data applications or users. All this information can be taken and applied with other business intelligence to create knowledge (Mangan et al., 2008). From here, knowledge workers can perform detailed analyses on this new knowledge and make informed decisions in terms of creating or adjusting plans to improve processes surrounding the tagged goods. It is in applications such as this and a myriad of others where we see first-hand the effect of the knowledge worker impact in supply chain management.

The role of the knowledge worker has a pronounced effect on the today's supply chain. Where traditional work in this arena was focused on the physical facets of the supply chain (i.e. physical contact/collaboration with suppliers, reengineering of the physical value chain to extract greater utility, the physical movement and distribution of goods), the knowledge worker's impact is often made with nary a hint of their own physical presence on the shop floor. This is largely due to the proliferation of data, technology, and business intelligence in the field of supply chain management which has afforded knowledge workers the ability to influence the organization's operations in manners unheard of until recent memory. This trend has not gone unnoticed. From Altekar (2005), "industry analysts believe the company's key supply chain knowledge workers will prevent or minimize cost, customer impact or security breaches when they are provided with real-time analysis and report tools designed to support this fast-moving and dynamic support service." As we move further into the knowledge era of supply chain, organizations will continue to look towards and depend on supply chain knowledge workers to utilize knowledge to create efficiencies where there was once wasted resources, provide safeguards against risks that were previously unchecked and most importantly, find value where there previously was none.

IV. DISCUSSION: BIG DATA GIVING WAY TO FAST DATA

In many business circles, the emphasis on large information sets have long been segregated into three buckets: volume, variety, and velocity. Regarding volume, it would not be a stretch to say that over the last few decades many businesses crossing a vast array of industries effectively dedicated billions of dollars annually in being able to capture and analyze large sets of data in hopes of gaining competitive advantages in the global marketplace. The need from businesses to not only have this data but to make sense of it required new approaches and unconventional thinking that may seem somewhat elementary now but was radical in its conception and application only a few decades ago. It was this need that spurred the big data movement that is still going on today. How this phenomena has now evolved into the fast data era will be touched on later in the section.

Regarding the varietal aspect of information, it is highly difficult to imagine companies of this time utilizing information that is limited in scope being able to derive a great deal of pertinent value which would afford them the opportunity to make the necessary adjustment to their operations to better serve their consumer base. Nonetheless, this was effectively the case for countless supply chains for many years. Numerous supply chains have grossly underperformed or failed largely due to having a

limited set of information from which to gain valuable insight. This led to the many companies having longer lead times which delayed deliveries, inaccurate demand forecasting, and the inability to adjust when there are demand reductions which caused downstream ripples in the supply chain (see “bullwhip effect”) amongst many other problems. This is largely why the information pool from which data is derived has to be broad in scope and come from a spectrum of information points. If you are yet to notice, the supply chains of today are markedly different than those of yesteryear. Whereas in the past, the point of information used to provide information on supply chain performance was usually derived from a fixed model or source that was updated only on an as needed basis, the supply chains of today utilize data from multiple points that varies in time and context providing a much clearer and holistic view on supply chain performance.

The velocity factor in supply chain information management does not merely speak to the speed in which data is available but also the ability to make better, more informed decisions derived from the analysis of the data much faster than before with greater accuracy. Due to the velocity factor within supply chain information management, supply chains are able to adapt much faster to changes, reduce cycle times, gain insight into creating potential synergies with their operations, and optimize the overall performance of the supply chain. Similar to Darwin’s evolutionary theory, the ability to adapt and evolve is what ultimately determines who survives and who doesn’t in supply chain management. Reverting back to the earlier discussion on volume, big data has proved time again that if analyzed correctly, that there is the great value found in large quantities of data. This is still very much the case and likely will be for the foreseeable future. Where fast data takes the baton is that it not only shows us the value in large data sets, it shows us that the closer to real-time the data is derived from, the more its value increases. With fast data, you do not just have a faster supply chain, you have a smarter supply chain. The insight from fast data will mean that your supply chain will be instrumented as well as interconnected. Instrumented in the sense that the supply-chain data that used to be manually entered will increasingly be generated by data capturing tools such as sensors, RFID tags, meters, actuators, GPSs, and other devices and systems. The interconnected aspect of the fast data supply chain means there are opportunities to take advantage of unprecedented levels of interaction through various mediums of communication (more on that in the next section) that will facilitate collaboration throughout the supply chain. This allows for greater transparency within the supply chain which means that issues that typically arise and can often cripple performance can be mitigated or even eliminated altogether. Having a smarter supply chain would have the analytic capability to assess numerous options in terms of supply, manufacturing, and distribution – and the flexibility to reconfigure flows as conditions warrant.

The unvarnished truth of the matter is simple. Today’s supply chains operate in a market that changes very quickly, has very fast product cycles, but also huge volumes with great demand volatility. In order for companies to stay competitive, the need to not only acknowledge but respond to this challenge means having the ability to not make strong commitments but deliver on them as well. Under-commitment and underperformance are not viable options. Supply chains require fast data in order to maintain high levels of agility and agile responsiveness, because having large inventory levels does not and will not mitigate the fast product cycles.

V. CONCLUSIONS

In this paper, the authors considered three trends (big data, social media and knowledge workers) which are believed to be pivotal in their role of the future of supply chain management. Not only do each of these individual trends add value to the field of supply chain management, they also interact in a triangular web to support the emerging supply chain. We have demonstrated how each trend contributes either in part, or across the entire supply chain mechanism to improve its performance and provide some key examples of these contributions. Moreover, we conclude that big data has already given rise to fast data, whose pivotal role in the development of supply chains is constantly evolving.

Our analysis shows that a key part of big data is not only data collection, but data interpretation or analytics which highlights a growing need for a talent to interpret the data and make effective decisions. The paper highlights the need for supply chain practitioners to be collecting data not only from the usual avenues, but also from social media and customer feedback. Supply chain knowledge workers can then use this information to obtain additional insights that allow organizations to drill deeper into a supplier's performance.

The future of this work is to examine in detail each of the stages of supply chain management for evidence of these key emerging trends, via theory and practical examples.

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