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FROM INTUITION TO ALGORITHMS

A Brief History of Using Analytics to Make Better Decisions

Late on a November night in 2006, along New York City's Bruckner Expressway in the South Bronx, a solid azure blue, brightly lit new billboard declared, in a single line of bold white block text:

THE ALGORITHM KILLED JEEVES.

The billboard stood out among the others hawking car dealers, reality TV shows, and sex clubs. Although it wasn't hard to get the "whodunit?" message, the billboard's sponsor was a mystery. A quick search, though, revealed that it was Ask.com, the search engine owned by the website conglomerate IAC Search and Media, Inc. Apparently its marketers had decided that a billboard along the Bruckner—the roadway home to the suburbs for the search engine's target user—would be a good place to announce that the dapper info-butler Jeeves had been dismissed for a better and faster model: the algorithm. The billboard was meant to draw attention to Ask.com's new and improved website-ranking algorithm called ExpertRank, and to contrast it with archrival Google's search algorithm, PageRank.

Geeky highway billboards, sponsored by cheeky web search engine marketers, are certainly signs of the times. Mathematical moguls are making vast fortunes by differentiating models that compute complex equations with extraordinary speed and

precision. "Once upon a time, the most valuable secret formula in American business was Coca-Cola's. Today it's Google's master algorithm," wrote Randall Stross, author of multiple books on internet-era moguls, in his *New York Times* column "Digital Domain."[1] An algorithm is a set of mathematically derived instructions to accomplish a defined task. Algorithms running on powerful computer networks are not just a part of the digital revolution; they are spawning a revolution in how business decisions are managed and made.

Of course, the seeds for this revolution—and for the digital technology that enables companies to apply such mathematical rigor to operational decision making—were planted long ago.

"Predicting short-term changes or shocks is often a fool's errand. But forecasting long-term directional change is possible by identifying trends through an analysis of deep history rather than of the shallow past. Even the Internet took more than 30 years to become an overnight phenomenon,"[2] writes Ian Davis, chairman and CEO of McKinsey & Company.

Today's digital data management discipline known as *analytics* began with the first mainframe computers in the 1950s. In this chapter, we look back over the past sixty years, not because the history of analytics and decision management is so fascinating (though much of it is, as you'll see), but to show you how far companies have come in using computers and analytics to achieve all of the following goals:

- To sort through the enormous amount of data they have about their businesses
- Which helps them make better decisions about serving their customers
- Which in turn improves the value they offer their customers as well as their overall profitability

If you share these goals, read on.

The Pioneers of Decision Management

Long before marketers were posting arcane mathematical terms on highway billboards, business pioneers were using math and computers to make better decisions. These business visionaries promoted a union of computing power, powerful equations, and brainpower to achieve business insights from deep and diverse analysis of operational data.

The First Use of Computers to Improve Decision Making

Back in the 1950s, at MIT's Sloan School of Management, computer scientist Jay Forrester argued that a large corporation is a complex social system far too abstract for human beings to manage effectively without the aid of computers. He asserted that we literally *need* technology to understand the relationships and interactions among people in big organizations. In 1961, Forrester published *Industrial Dynamics*, his seminal book on systems dynamics—an analytical, problem-solving methodology he developed that employs computer-based simulations to help managers visualize and understand cause-and-effect relationships in decision making and business processes that would otherwise be invisible and inestimable.

Forrester also used the term *mental models* to describe how people tend to make decisions based on instinct and interpretation rather than on fact. Forrester believed that management decisions based only on mental models and human judgments are inferior to decisions derived from computer models that can represent complex relationships and predict outcomes that the human mind can't. In the 1970s, Donnella

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Meadows, a protégé of Forrester's from MIT, applied his theories of systems dynamics to produce a global model for the Club of Rome that was the basis for the controversial book *Limits to Growth,* which predicted all of the long-term trends in population growth, economics, and the state of the earth's environment that have since come to pass. Another Forrester protégé, Peter Senge, popularized systems dynamics in a management context with his book *The Fifth Discipline*. Decision management arises from the same notions of systems complexity.

Whereas Forrester advocated for more computer-guided management of business systems in the 1950s and early '60s in Cambridge, the International Business Machine Corporation—now known simply as IBM—was making its transition from punch card processors to electronic computers. Thomas J. Watson, Jr., bet the company's future on the thinking machines his father had dismissed as too expensive and unreliable. Taking charge in 1952, the younger Watson hired hundreds of electrical engineers to start designing the first mainframe computers. Little did he know that this decision to commit IBM's business machine vision to computers would kick-start the information technology revolution in business and the beginnings of decision management in large corporations.

Fair Isaac's Formative Days with Decisions Management

At about the same time, in California, two young process management scientists—William R. Fair, an engineer, and Earl J. Isaac, a mathematician—were starting their careers in the new field of operations research. Then, as now, operations research involved applying advanced mathematics and statistics using computers to analyze complex operational business processes to improve the process through better decisions. Bill and Earl met in 1953 at the Stanford Research Institute (SRI), a think tank that primarily did operations research for the military. Bill and

Earl spent their days as operations research scientists at SRI, helping the U.S. Defense Department figure out how to contain the destruction of an atomic bomb. They created elaborate mathematical models to run on SRI's behemoth computer in order to answer basic questions. Their concern was not how to build missiles and atomic weapons, but how to operate them. How do you carry them? Where do you aim? How close to the target?

Bill had studied engineering at the California Institute of Technology in the 1940s. During World War II, he had been a radar technical representative for Sperry Gyroscope and had served in the Pacific with the Marine Corps. As a civilian, he also applied his engineering skills repairing night fighter radars on aircraft carriers. After the War, Fair finished his schooling at Berkeley and Stanford. Isaac, who studied mathematics at the U.S. Naval Academy and UCLA, had been part of the team that developed the initial programming for one of the first electrical computers—the U.S. Bureau of Standards Electronic Eastern Automatic Computer, otherwise known as SEAC.

As Bill progressed in his career at SRI and his analysis of operational processes for missile systems and atomic weapons, he became convinced the research they were performing for the military could be just as valuable to *businesses*. Why couldn't the operational analysis performed for the Defense Department be applied in other contexts, like corporations serving consumer product and service markets? He visualized the corporation as a sensitive machine similar to the radar systems he had repaired during the war. Like Jay Forrester, he believed that managers needed computers and mathematics to solve tough operational problems and to make consistently better managerial choices.

Bill founded SRI's first nonmilitary operations research practice, and he asked Earl to join his group. It wasn't long before the independent and ambitious duo decided to leave SRI to form their own consulting business for the private sector. In an interesting turn of fate, Bill had taken half his courses at the business school while working toward a master's in engineering

at Stanford. Combining Bill's head for business with Earl's rare computer talents and passion for mathematics, in 1956 they each chipped in $400 to start Fair, Isaac and Company, Inc. According to Fair Isaac lore, Bill and Earl decided to combine their own last names to come up with a name for the company, but they were concerned that "Isaac Fair" sounded like one person and "Fair Isaac" sounded like a used car salesman. As Fair tells the story, they "settled on the lesser of two evils." Bill Fair was among the attendees at the First International Conference on Operations Research in 1957, just after they named their new company.

Bill Fair and Earl Isaac founded Fair Isaac because they believed, as did their business-minded engineering and mathematician peers, that the operational processes of corporations conceal a treasure trove of information to help managers run better companies. For an organization to be the best, its operational management decisions must be methodical and data-driven—not just guided by gut feelings and consensus. Their vision was to create computer-based mathematical tools for use by corporations to sharpen operational decision making and make process management the foundation for achieving consistently better business results. Fair and Isaac knew they could do the math and the analysis. The only glitch was that computing technology was still too primitive, too scarce, and too expensive.

In the 1950s—when men wore hats, not headphones, and computers were the size of a tank—few companies even used computers or would have known what to do with it if they had one. Even Bill and Earl didn't have their own a computer, so they worked out a time-share deal with the Standard Oil Company of California (today's Chevron) to use its mainframe during nonpeak evening hours to conduct their research. The SEAC machine Earl had worked with had been a physical monster with a grand total of only 512 words of high-speed memory. Earl contributed to the development of many of the early computer languages, but his thorough grounding in machine language and even in bit

programming, along with his natural talent for the subject, gave him an understanding of the nature of the computer that was equaled by few people in the world at that time.

Fair Isaac Takes Off with the U.S. Credit Card Industry

It took the fledgling company almost three years, but in 1958, Fair and Isaac and Earl Follett—a fellow mathematician, alumni of SRI, and Fair Isaac's first employee—identified consumer credit as a process in which they could put their ideas to work. By the 1960s, as more business operations started to be computerized, and credit cards became an accepted alternative to cash, suddenly it was possible for companies to capture data on customers' behavior. When people pay cash for goods and services, it is an "anonymous" transaction. The only record of the transaction is the receipt. For the first time, companies could capture transaction-level data on masses of people.

Credit Scoring Drives Better Decisions and Growth in Consumer Lending. Credit card issuers were interested in seeing trends (that is, what people were buying or not buying). They were even more interested in knowing more about how to manage the risks of mass market lending. Fair Isaac invented the credit score to help lenders analyze each applicant's credit risk while handling many more applications than they ever had before. The credit score was the first big application of analytics for Fair Isaac, and the beginning of what the company today calls decision management.

A few companies had dabbled in business applications of scoring as early as World War II, but none thought of applying it to consumer lending. As operations research experts, Bill and Earl were familiar with statistical analytic techniques such as multivariate analysis and logistic regression. Earl Follet knew how to apply these concepts to managing credit risk. When

Fair Isaac's first credit scoring model was introduced in 1958, it was the first to use the historical data being captured by finance companies to predict a person's creditworthiness based on their past behavior. The model produced a score, based on analysis of specific sets of numbers related to variables such as a person's bank balance and payment records. The credit score was a far better predictor of a customer's ability to pay back a loan than any decision a banker could make on his own, even if he knew the applicant personally.

Using Predictive Analytics to Make Better Decisions About Customers' Behavior. Predictive analytics is a way to make connections between the past and the future, using historical data to predict future events. Simply put, it's the study of how what you know at the time you make a decision relates to what you don't know: what will happen in the future. The credit-scoring model was built based on variables such as these:

- Income
- Bank account balances
- Outstanding credit
- Payment history
- Time with present employer

These variables were vetted as highly predictive of a consumer's creditworthiness.

Credit scoring models, and the type of predictive analytics Fair Isaac is known for generally, quantify the patterns and relationships among dozens of variables. Every credit application had all the data needed to build the model. A single score could convey the risk associated with a person's future payment behavior and the person's risk profile relative to the behavior of many other people. Using mathematics to predict the behavior of masses of consumers was a revolutionary concept when first

proposed. Today, credit scoring is a cornerstone of lending processes, and other analytic applications using data on consumer behavior are revolutionizing mass advertising, direct marketing, and customer service—to name a few business processes that are spawning new, creative analytic applications.

Fair Isaac's first foray into credit scoring, however, took more than a decade to take off. In fact, Fair Isaac didn't sell a credit-scoring system to a bank's credit card division until 1970. The first general-purpose FICO® score was not developed until 1989. It took time for business attitudes and technology to change.

In 1958, Bill and Earl sent letters to about fifty major credit grantors—mainly consumer banks and finance companies—in the United States asking for a meeting to explain credit scoring and its value. Only one institution replied. More often than not, business clients showed little interest in operational insights. All they wanted was to install their first computer and get it running. The idea of the computer as a tool for analytic computation was way ahead of what business people were thinking.

Still, the timing for scoring was right, because it coincided with growth in nonbanking businesses that were offering credit and capturing the data. Early charge cards (which were metal, not plastic) had been around since the 1930s. By the late 1950s, consumer use of cards rather than cash was growing, and metal charge cards were being replaced by the plastic credit cards we use today. Although Fair Isaac's first credit-scoring system sale was to American Investment—a finance company based in St. Louis, Missouri—banks were initially reluctant to adopt the new credit-scoring approach.

On the other hand, national department store chains—such as JCPenney, Montgomery Ward, and Sears, Roebuck—were intrigued by the idea of a systematic way to grow their store charge card bases at a time when few people had credit cards. Montgomery Ward, one of the first U.S. national department store chains, was one of Fair Isaac's best and most progressive clients. As credit cards took off in other consumer service

industries (gasoline retail and hotels), more businesses became interested in credit scoring.

But the information management tools and processes were still basic. Before oil companies and department stores began automating their accounts receivables and billing processes, customer account records were stored on ledger cards coded from handwritten account information. Ledger cards were created and maintained using the National Cash Register (NCR) Company's billing machines—which had one keypad for debits and another for credits—to calculate balance, finance charges, and so on. The ledger cards, posted manually, listed information about each customer's charge purchases—the dollar amounts, what they bought, and the date.

As late as the mid-1970s, Fair Isaac staffers had to spend days in their retail store client's backroom credit card operations so they could gather the data to build their models. They used a microfilm camera to photograph the information from the ledger cards. Larry recalls that during the summer of 1974 he drove from store to store, photographing thousands of records and praying the images would come out so that he would not have to go back and do it all again. While onsite, he also listened to the store's collection department staff calling delinquent customers. He recalls that it was eye-opening to see the reality of the process Fair Isaac was trying to improve.

Through the mid-twentieth century in the United States, the granting of credit occurred only between businesses. The process was completely based on human judgments, including conclusions that would be socially and legally unacceptable by today's standards. (From the 1920s to the 1930s, merchants relied first on gender and race to assess their suppliers, along with "character traits" such as honesty, punctuality, and sobriety.) It wasn't until the 1940s that it was possible to collect real and accurate data on an individual's actual credit and payment history, which turned out to be fundamental predictors of a person's reliability as a user of credit.

Although there are consumer advocates today who still question whether there is racial bias in credit scoring processes, Fair Isaac, from the start, literally took prejudice out of the equations. In the early years, some lenders balked. Earl Isaac refused one banker's insistence that race be a variable in their scorecard. Another lender put a secret code on loan application forms from minority applicants. Scoring killed this practice. (In fact, after the Equal Opportunity Act was adopted in the mid-1970s, some lenders were ordered to use scoring in their decision-making process.)

Diners Club and Amex Issue the First Expense Account Cards. The big surge in general-purpose credit cards began after World War II. In 1950, department store baron Alfred Bloomingdale and his partners Frank X. McNamara and Ralph Snyder created the Diner's Club Card for use at select restaurants and stores. Diner's Club was the first credit card aimed at getting a piece of the travel and entertainment expense accounts of young and prospering veterans who were now ambitious corporate organization men. In 1958, the same year Bill and Earl brought the credit score to market, American Express, best known then for inventing the traveler's check, issued its first card aimed at businessmen.

Carte Blanche Takes a Tiny Step in Tracking Delinquent Accounts. The same year, Conrad Hilton, of the hotel chain, also jumped into the burgeoning credit card market targeting prosperous organization men. With a grand panjandrum's flair, he named the company's card Carte Blanche. Like other credit card promoters of the day, Hilton aggressively marketed the card, but he wasn't terribly analytical in his approach. The company sent the Carte Blanche card to every guest who stayed at a Hilton hotel and signed up any merchant who was willing to accept the card. To compete with Diner's and Amex, Hilton agreed to take a lower (4 percent) share of each charge, and he

was willing to issue cards to people whose payment histories did not make the grade with other card companies. But this strategy for growth was a nonstarter for all the new card companies. Diners Club also tried to compete with other card companies by reducing its credit standards, but it abandoned that strategy after default rates rose to an unacceptable level.

Fair Isaac did work for Hilton in the early 1960s, but Carte Blanche was not a scoring client. Fair Isaac was brought in to design a billing system. No one inside the company had given any thought to any aspect of managing the billing process for the card. Bill and Earl found out just how bad the situation was when they arrived at Hilton's offices in 1961 to start working. They opened a closet door and found stacks of mail sacks on the floor, filled with *hundreds of thousands of dollars*! There was no system to manage the money, much less a way to manage the enormous volume of data and transactions that the Carte Blanche credit cards were generating.

Earl used punch-card equipment he had on hand for another client to design and install a billing system in a week. Hilton executives were dazzled. They told Earl this was the closest thing to a miracle any of them had ever seen, but apparently this feat wasn't enough. Unfortunately, Hilton's billing snafu was reported in the press: *Time* magazine ran a story called "Carte Blank" in April of 1961, which revealed that Hilton would lose $4 million for the 1961 fiscal year (which ended that month). The reason, as Carte Blanche officials told *Time*, was "our unsatisfactory collection experience."[3]

Two months earlier, Conrad Hilton and several associates had pumped $5 million into the corporation to cover credit card losses. To reduce its risk exposure, the company tightened its credit checks and created new requirements for cardholder applicants: "25 years of age, at least $7,200 in annual salary, and an established pattern of wise and consistent use of credit."

By then Hilton also had an IBM computer system in place, which checked daily on the state of the accounts and sent out

reminders to delinquent cardholders. Carte Blanche's credit checks and automated account status monitoring were the first steps in using transaction data to put more science behind the management of their marketing and billing processes. Rudimentary as it was, Carte Blanche's decision to send these reminders to delinquent cardholders was early decision management. Today's technology, applied in a bank collection process, automates these kinds of decisions and can create strategies to improve responsiveness from millions of individual customers.

Citibank Invites Everyone to Join, Without Assessing Any Credit Risk. When Citibank decided to take its Citicard credit card business national under former CEO John Reed's leadership in the 1970s, the bank actually mailed offers by using lists from phone books across the country. The losses on this direct mail campaign were in the millions, but Reed shrugged his shoulders and said it was just a cost of building the business quickly. But they never did it again, until a senior executive with a background in analytical modeling stepped up to articulate a discipline for balancing risk and reward in acquiring new customers.

Mass Marketing and Mass Consumer Data Emerge

Mass marketing of credit cards changed the customer growth possibilities for banks and for consumer lending generally. Not only did credit cards make it possible to reach millions of more people with a personal credit product, but it also gave card issuers a more direct way to track and influence their customers' spending. In the consumer lending business, the credit card and the credit scoring process supported the financial services industry's growth from its traditional base in single hometown banks and savings and loans to national branch networks.

Consumer lending in the United States, before and after World War II, was part of the fabric of cities and towns and

communities. The saga of the greedy Mr. Potter and the hero George Bailey in the American holiday classic *It's a Wonderful Life* set its timeline from the 1920s through the 1940s. Local bankers were pillars of the community who socialized with many of their customers. By the 1970s, though, national consumer finance companies, such as Household and Beneficial Finance, had several thousand branches scattered in towns around the country. They strove for local trust and the personal touch, running radio spots with neighborly slogans, such as Household Finance's "You're good with us" or Beneficial Finance's "With Beneficial, you're good for more." When you walked into a local office and filled out an application for a loan, a branch manager—who also happened to be the credit officer—reviewed your application, sized you up, and made a decision whether or not to give you a loan. In other words, the marketing and customer experience was supposed to be very personal, which is a nice way to run a small-town general store or bank but not a very practical or profitable way to run a national retail bank system. For that, banks needed a systematic way to raise the volume and speed up the processing of loan applications and manage the risk in lending to more people. Credit scoring was just the system to tackle all these new challenges.

Today, credit scoring is a standard tool to manage credit, and it is used throughout a variety of industries; for example:

- All retail banks use credit scores to manage everything from loan approvals and interest rate levels to lines of credit for a wide variety of lending products and for millions of customers and prospects.
- Insurance companies also use scores in deciding individual customer eligibility and which services to offer.
- Health care organizations are beginning to use scores to determine who they should pursue to collect delinquent fees and who they should write off.

ASAP: The First Automated System for Processing Credit Applications. It took so long for credit scores to catch on in part because computer technology still had to catch up to the vision of mass automated decision making. Right up until the early 1970s, not only were credit applications submitted and reviewed *on paper,* but scorecards were also deployed *in a manual environment*. We take for granted today how pervasive automation is in businesses and many other aspects of our lives, but if you were working a few decades ago (as *we* were), you'll recall offices with typewriters and adding machines instead of a computer on every desk.

We could use scientific methodology to help us make decisions, and we could use information technology to help provide mass customization.

So it was a groundbreaking achievement when Earl Isaac came up with the idea to use a computer to automate the processing of credit applications. He wrote the software for a system called the Automated Strategic Applications Processing (ASAP) system, and he created a computer language known as PROSPER.

In 1972, Wells Fargo Bank bought its first ASAP system. The first ASAP seems unfathomable today. The product ran on a Data General Nova minicomputer that was hardly a mini machine—actually it was one step away from the data processing center full of refrigerator-sized mainframe computers. The Nova had only 8 kilobytes of memory (compare *that* to the memory of 1 to 2 gigabytes in a typical laptop today) and a prechip computer-processing unit that measured 14 by 14 inches (today's CPUs are 33 by 33 millimeters, a tiny fraction of an inch).

Automated loan application processing became a mainstay product for Fair Isaac; we developed versions for mainframes, then PCs, and then the Internet, as each technology advanced. But the real significance was this: with ASAP, Fair Isaac entered the software business, and the company found that the automation of the loan approval process was as valuable as the mathematical formulas used to score applications. The move from

handwritten accounting books and ledger cards to the automation of the analytic models was the key to mass-scale lending and making millions of consumer loans.

Improving Credit Account Decision Managements via Adaptive Control. Larry Rosenberger joined Fair Isaac in 1974, fresh out of school. With undergraduate and graduate degrees in physics from MIT and the University of California at Berkeley, and a Ph.D. in operations research from Berkeley, Larry was eager to put his education to work. As he saw it, Fair Isaac's mission to help companies analyze and improve decision making in complex operational processes would offer him a lifetime career of study in systems dynamics as well as an endless supply of interesting business puzzles to solve.

Indeed, one of Fair Isaac's most important credit scoring technology innovations started with just such a problem, and some scribbling on the back of an ink blotter. The problem was this: in the mid-1980s, banks weren't buying behavior scorecards that measured customer risk after a loan was booked, because the scorecards were too hard to install and use in their client's computer systems. Bill Fair illustrated how control theory might be applied to solve this problem, and Larry ran with the idea.

Both Larry and Bill had a sophisticated understanding of control theory, using both engineering and mathematics to analyze systems. Simply said, in any system inputs can be controlled to obtain the desired output. Larry saw in Bill's drawings the opportunity for Fair Isaac to go beyond just creating the algorithms for scorecards, to building an automated system in which the scorecards would operate. The technology was named *adaptive control*. Chapter Four will explain adaptive control in detail, but for now, all you need to know is that adaptive control changed the way credit card issuers manage decisions such as these:

- Adjusting a customer's line of credit so that the risk of delinquency is controlled as the line of credit is increased

- Accepting or declining a credit card used at a checkout counter or online (for example, a customer can make a purchase over the credit limit, if automated analytics approve it)

In both decisions, the automation of the analytics works to optimize profitability and minimize risk for the business and to increase convenience and good will for the customer.

The Scoring Tool Digs into Credit Bureau Data. In 1989, another big breakthrough for the credit industry came when Fair Isaac installed its first-general purpose credit bureau scorecards at Equifax, one of the three major credit bureaus in the United States. With these scorecards, any lender could measure the credit risk of an applicant or current customer—at a cost of just pennies per transaction. The huge amounts of data the credit bureaus had amassed made these scores more accurate and useful in making credit management decisions.

Capital One's Customer Card Revolution. The science and creativity of predictive analytics and automated decisions gained momentum in the credit card industry at the beginning of the 1990s, as "plastic" became as ubiquitous as cash. For example, consider the difference thirty years made to the credit industry:

- In 1970, only 6 percent of American householders carried a credit card balance.
- By 2000, 40 percent of householders carried one or more credit cards.[4]

In the 1990s, all leading credit card companies, such as Capital One, First USA, and MBNA, were using information technology to churn out new credit card products and supercharge revenue growth and growth in market share while keeping the lid on costs. MBNA and Capital One stood out for their focus on customer profitability. Both were interested

in consumer behavior, but their approaches were very different. MBNA invented the "affinity" card, a product cobranded with professional associations. MBNA targeted segments they believed would be receptive and lucrative, such as those for doctors, lawyers, and university alumni. They did not use analytics. Capital One did and created the first mass-customized marketing and customer service in the industry while managing the profitability of each customer relationship.

Like Bill Fair and Earl Isaac, Richard Fairbank and his partner Nigel Morris came from the management consulting world, and they had the mathematical skills and a vision of what computers could do with equations to help managers make better decisions. They coined the term *information-based strategy* to describe their pairing of scientific management with information technology.

Here is how Richard Fairbank—chairman, CEO, and cofounder of Capital One—described their operational vision for his company: "When we started this company, we saw two revolutionary opportunities. We could use scientific methodology to help us make decisions, and we could use information technology to help provide mass customization."[5]

Capital One took testing, learning, and automation of analytical models in retail banking to a new level—which was why the company was profiled in *Fast Company* magazine, detailing extraordinary results like these:[6]

- In 1994, "Cap One" was an adventurous spin-off of Signet Bank, a small regional consumer bank that was based in the small town of Springfield, Virginia. By 2005—only eleven years later—Cap One had become the 115th largest company in the S&P 500, with annual revenues of $10 billion.
- "Capital One has enough information on consumers to fill the hard drives of more than 200,000 personal computers . . . It uses that information much as a physicist uses a particle accelerator: Cap One analysts and product managers come up with

an idea for a product, bounce the data a bit, test it, tweak it, and launch it as fast as possible."

- In 1998, the company performed twenty-eight thousand tests of new products, new advertising, approaches, new markets, and new business models.
- In 1998, the company offered six thousand kinds of credit cards, each with slightly different terms, requirements, and benefits, and each requiring a slightly different monthly statement.

> The decision-making potential in the volume of data accessible to all businesses has become a deciding factor in their success.

In the early days of direct marketing of credit cards, companies made a single fixed offer, and they randomly searched for people who would accept the offer. In contrast, Cap One mined dozens of databases to design thousands of slightly varied credit cards. Then the company targeted each design for precisely defined customer segments. Each segment had different means and tastes, but all had a high probability of signing up and becoming a profitable customer. Consider the following wildly different examples:

- A suburban family man in his forties, with a six-figure income, and a taste for fine cars and wine, might get a $20,000 credit line with an affinity card comarketed with Mercedes-Benz, with no annual fee.
- In contrast, a typical offer to a recent college graduate might be for a $200 credit line with a $20 annual fee.

Computer systems and technology tools enable companies to apply math and statistical disciplines to decision making with an exactness and scale that Bill Fair and Earl Isaac couldn't

have imagined back when they were working with Hilton and grappling with the sacks of cash stuffed into closets. Cap One's information-based strategy, as applied in the company's call center operations, was a state-of-the-art advancement for the credit card industry nearly a decade ago, and it remains so today. The fast, interactive customer environment created through Cap One's early analytics was a leading indicator of how company and customer relationships would evolve in the age of the Internet. Like all retail banks, Cap One was caught up in the subprime mortgage crisis of 2008, but over the years its competence in analytics has helped the company weather economic downturns and industry volatility better than competitors. We will talk more about its recent innovations in analytics in Chapter Four.

Different Companies Use Analytics Differently

Companies competing on analytics typically differentiate their algorithms. But sometimes companies using the same models may decide on very different business strategies.

Allstate versus State Farm versus Progressive

Consider the role analytics played in the American auto insurance market over the last fifteen years. State Farm Insurance Company, founded in 1922, and Allstate Insurance Corporation, founded in 1931, are well known to American drivers. A third company, Progressive Insurance, has been selling auto insurance almost as long (it was founded in 1937), but before the 1990s it was not the household name the other two companies were. Today, Progressive is the third largest insurer in the United States (13.8 billion auto insurance policies sold in 2007). Progressive also positions itself as an industry innovator. In the 1990s, its service at the scene of the accident was ahead of the industry. In 2007, Progressive became the first insurance company to offer coverage for injuries suffered by pets in automobile

accidents. It pays up to $500 for veterinary bills for dogs and cats. The protection is included at no additional charge for customers who buy collision coverage.

Another example of Progressive's innovation has to do with a counterintuitive market it was able to cultivate through the use of analytics. Historically, most auto insurance companies used the same predictive model to assign risk to drivers and the same criteria to identify bad drivers. (Hence, "If you have these characteristics, you are 90 percent likely to have a claim.")

State Farm and Allstate took that information and decided to set pricey premiums to discourage people with bad driving records from applying. This was the strategy: charge customers even more than necessary to make a profit. Progressive took the same behavioral information and tried to attract drivers rejected by their competitors. Before they even did the modeling, they had a hypothesis that they could make money from "bad" drivers. Then they used analytics to find a policy price just slightly below State Farm and Allstate but high enough to make a profit on customers who were likely to submit a claim.

Progressive used segmentation analytics to identify bad drivers, and a scoring model to differentiate the best of the worst from the worst (a 600 score is different from 550 and very different from 500). The other insurance companies lumped together all bad drivers (for example, any applicant with a score below 600).

Progressive's new customer growth went through the roof. Once the company dominated the bad driver market, Progressive diversified into more standard and preferred risk segments. The lesson: you can't intuitively price something precisely without analytics. Yet this is also an approach that combines scientific method and intuition. This ability to differentiate services and pricing and to meet a market need that other companies do not see is one important reason why analytics is such a powerful resource for gaining a competitive advantage.

Progressive may have had better statisticians than the other insurance companies, and they may have built a slightly better

model, but that was not the deciding factor in their success. It was the decision to take a precisely calculated risk to go after those people with scores below 600 when other companies stayed away.

Big Companies Have Big Data Sets

Automakers and apparel makers, beverage makers and appliance makers, electronics makers, luxury hotels, banks, grocers, discount general merchandise retailers, and direct mail marketers have all chased the dream of using consumer data and analytics to identify new markets and do one-to-one marketing, mass customization, and personalization of products and shopping experiences, with varying degrees of success. Now they have the volume of data accessible to make the models more useful, because more data is being generated and the cost and complexity of collecting and storing data are no longer hurdles. Plus, processing is getting faster and faster, simply because computers are connected.

Cap One's cofounder Nigel Morris, speaking to Ann Graham in 2007, summed it up well: "Big companies now have big data sets on consumers so they have the raw materials to work with and that is a big asset . . . People can point to the insurance company, Progressive, and Harrah's, the casino company, and Capital One, and they can say, these companies have really leveraged this kind of information to create powerful consumer-based models. They are beacons that give other companies confidence that it might make sense for them to build this capability, too."

Even with the problems caused by using analytics and automation to extend credit to more and more people, there is no question that more people who qualify for credit and benefit from it have access to all types of credit products today. Not only has credit scoring made lending processes more efficient, but it has also made them more democratic and objective.

The credit score is a simple mathematical way for a lender to make sure its terms are met, or at least reduce its exposure to consumer default risk, by selecting data that are predictors of a person's creditworthiness. In theory, this eliminates human bias from the process. Of course, in practice mathematicians still select the criteria to be used in the model. Credit scoring is not a perfect science, nor is any analytic model. As Kurt Gödel—a twentieth-century logician, mathematician, and philosopher—said, "Mathematics is perfect, but it is not complete."

We've presented a bit of the recent history of consumer credit in the United States to demonstrate the role that computer-based analytics and automated decision making played in the twentieth century to dramatically increase the scale, speed, and quality of a single business process: consumer lending. Working with mere millions of kilobytes (one kilobyte is equal to the amount of data stored on an antiquated 3.5-inch floppy disk) and megabytes (one megabyte equals a pickup truck filled with paper), back in the 1970s Fair Isaac and our clients made analytics a catalyst for business innovation. Indeed, Harvard Business School's Clayton M. Christensen has called the development of credit scoring, which subsequently led to automated credit approvals that accelerated and transformed the credit card industry, one of the top seventy-five disruptive business innovations of the twentieth century.[7]

How Analytics Is Being Used in the Twenty-First Century

The science of predicting consumer behavior and the art of using those predictions, which Fair and Isaac envisioned when they began building their business thirty years ago, is blossoming in the digital age.

The ability to use data to predict consumer behavior, and identify and differentiate markets, becomes more powerful as the volume of data grows. In 2004, Wal-Mart's data warehouse

reached 500 terabytes (one terabyte equals fifty thousand trees made into paper and printed). Data flows on the Internet are now reaching into the exabyte range. In 2008, the Discovery Institute projected that by 2015 internet protocol-based data traffic in the United States will reach an annual total of 1,000 exabytes. Two exabytes equals the total volume of written information generated worldwide annually. Five exabytes is all the words ever spoken by human beings.[8]

As we noted earlier, the costs of collecting and storing data are falling steadily as processing power increases. Chris Anderson (editor in chief of *Wired* magazine and author of *The Long Tail*) has noted that data management costs are falling so fast that they are already too low to measure: "The cost of storing or transmitting a kilobyte of data really is now too cheap to meter . . . Soon the same will be true for a megabyte, and then soon after a terabyte."[9]

Digital commerce and communications infrastructures have set the stage for business process innovations in many consumer industries today—including health care, retailing, mobile communications, and perhaps industry categories that don't even have names yet! In his first book, *The Concept of the Corporation*, Peter Drucker, the legendary and prolific management thinker, argued for the economic importance of creating community and meeting individuals' social needs.

Ancient mathematics combined with modern computers give companies the best management tools they have ever had to profitably serve needs in society—often, needs that have never been met.

That book was published in 1939, yet seventy years later ancient mathematics, combined with modern computers, gives companies the best management tools they have ever had to profitably serve needs in society—often, needs that have never been met. Indeed, there have never been more exciting new possibilities for corporations to use masses of transaction data to create better business models and more

efficient operations that lead to social and economic benefits for everyone.

How Google Rules the Internet by Advertising with Analytics

Google is well known for being able to build a business model around analytics, as there really is no company in the world that surpasses its skills in using math to make money from digital data. Google's founders, Sergey Brin and Larry Page, made their breakthrough in search engine algorithms by meticulously counting and weighting links between and among millions of web pages. Advertising is its biggest revenue source today, but Google is constantly doing R&D to find the next big products and business models.

As we all know, every time a person uses the World Wide Web to shop, to learn, or to relax, he or she creates a data trail that has a story to tell. Any business that has the tools to analyze data from the Internet or other digital channels—and the imagination to piece together the story—has the opportunity to create business value. But as we also know, companies founded in the Internet age are not the only leaders in analytics.

Any business that has the tools to analyze data from the Internet or other digital channels—and the imagination to piece together the story—has the opportunity to create business value.

How Tesco's Analytics Creates Unique Shopping Experiences

Tesco, plc, founded in London in 1919 (the Tesco name was taken in 1924), is now the largest grocery and general merchandise retailer in Great Britain by both global sales and domestic market share, and the fourth largest grocery retailer in the world. The company is also a world leader in the mass retail industry

for it application of analytics to create unique and personalized value for individual customers. Dunnhumby, a U.K.-based consulting firm specializing in analytics, has worked with Tesco since 1991 to grow this capability. Dunnhumby created algorithms to run Tesco store operations that analyze and make decisions based on a flow of data and analysis of transactions generated by interactions with *thirteen million* Tesco ClubCard members across *fifty-five thousand product lines*. Tesco now owns a majority share of Dunnhumby, which has also entered into a joint-venture with Kroger, the U.S. supermarket chain.

Years of investments in analytics have enabled Tesco to differentiate its customer experience from competitors'. Although Tesco has not invested in the specific decision management technologies we will discuss later on, it has created a world-class system to make a variety of inventory management and marketing decisions to maximize per customer profitability. Tesco also emphasizes creating value from customer data to make decisions to achieve personalization and convenience for customers that keeps them coming back. (We'll describe Tesco and its ClubCard loyalty program in more detail in the next chapter.)

Companies in emerging markets are coupling analytics and information technologies to come up with business innovations not yet seen in more economically mature countries.

It's not just international giants that are using analytics successfully. There are plenty of companies in emerging markets investing in decision management technology that are coming up with business innovations not yet seen in more economically mature countries. For example, Akbank, Turkey's largest consumer bank, started developing a banking service using mobile phones as a direct-to-consumer channel in 2006. You may be surprised to find out that in the United States, most money center retail banks didn't begin introducing limited mobile banking

features (such as checking your bank balance) until *2007*, a year after Akbank did in Turkey! Akbank is using a variety of profit-optimization and risk-management decision models, with other banking products, to promote controlled growth, as the bank seeks profitable relationships among diverse consumers, from the ultra-affluent customer to the rising "mass" affluent to first-time account holders. (Chapter Seven provides a more detailed case study of Akbank.)

Decisions in a Post-Managerial World

Consumers are demanding interactive dialogues at a place and time of their choosing. This requires businesses to make more real-time decisions, and more decisions that personalize every transaction, in ways that are of the highest value to each company's customers and that are most profitable for each particular business. As consumers of all generations become more comfortable with and accustomed to interactive and automated commerce, they are coming to expect convenience, a personal touch, and instant gratification.

> Companies are using analytic models to *automate* decisions or *guide and support* mid-level managers and frontline workers as they manage tasks that affect customer value.

In many cases, there are still competitive and practical implementation issues that prevent large companies from serving a true market of one, but the ability to profitably serve millions of unique customer segments is becoming a reality; moreover, in some industries, it's a competitive necessity. Inside corporations, the silos of autonomous product lines, departments, and geographies are slowly coming down. Making decisions in an environment where functional boundaries are falling and the pressure is

on managers to do more with fewer people and tighter budgets demands unprecedented information visibility and coordination at an enterprise level. Coordination and collaboration are *in*; bureaucratic behavior is still prevalent but on its way *out*.

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Strategic plans and competitive responses that used to be analyzed and rolled out episodically over a period of months (or even years) are now happening, in some cases, overnight or in real time—for example, decisions to adjust prices, product features, or the ways in which different customers are treated. And as companies get larger and more complex, it becomes increasingly difficult to translate executive strategy—especially customer strategy—through layers of decision makers, all the way to the frontline people who are closest to the customer. As we pointed out at the beginning of this chapter, Jay Forrester said way back in the 1950s that the modern corporation was too big a social system to manage without computers. Think about that comment in the context of the typical large twenty-first-century company, with two hundred thousand people carrying out millions of decisions every day, based on maybe five decisions made by ten people at the top!

You must enable businesses to make thousands and thousands of individual decisions. . . . but you have to create the infrastructure to make it easy.

Many businesses have spent years squeezing cost savings from automating and outsourcing clerical and basic administrative tasks. Now companies are focusing on more complex decision-making productivity: using decision models and automation to *drive*, *guide*, *and support* decisions of mid-level managers and frontline workers as they manage tasks that affect customer value.

In a freewheeling conversation in *The McKinsey Quarterly*, Lowell Bryan, a managing partner at McKinsey, and management guru Gary Hamel discussed the nature of the "post-managerial society" that Hamel describes in his 2008 book, *The Future of Management*. "Increasingly, the work of management won't be done by managers. Instead, it will be pushed out to the periphery. It will be embedded in systems. The idea that you mobilize human labor through a hierarchy of overseers and bureaucrats and administrators is going to look extraordinarily antiquated a decade or two from now," said Hamel.

Bryan responded: "These thinking-intensive people are increasingly self-directed. In fact, they're directed as much by their peers as they are by their supervisors. The management challenge is akin to urban planning. The art of it is that you must enable people to make thousands and thousands of individual decisions. . . . but you have to create the infrastructure to make it easy."[10]

In Chapter Four, we will describe the automation of analytics software that makes this art and science work, as well as Fair Isaac's view of how a decision management infrastructure that automates, improves, and connects decisions is built over time.

Conclusion

The business notions and phrases *decision management* and *competing on analytics* did not exist when Bill Fair and Earl Isaac started the Fair Isaac Corporation. They still called what they were doing *operations research*. Scoring models were one of the first innovations and examples of what Fair Isaac considers to be a decision management tool, although operations research is still thriving and recognized as a profession. Indeed, the Institute for Operations Research and the Management Sciences (INFORMS)—the operations research profession's largest trade association, based in the United States—calls operations research the "science of better" and has even claimed scienceofbetter.org

as its URL on the Internet (an idea we wish we had thought of first).

But we do claim decision management as one of operation research's progeny; it is a business discipline growing in influence. Scoring was a disruptive innovation in consumer lending, and adaptive control technology played a critical role in the rapid growth of the credit card industry. Over the next two decades, many new technologies and techniques will emerge in retailing, health care services, insurance, and mobile communications and other transaction-intensive businesses poised for growth and disruptive innovations. Decision management technology, which includes the automation of analytics in operations and the connectivity of decisions, is a critical part of the infrastructure that is making this happen.

But it is important to keep in mind that decision management technology is not, and never has been, intended to completely replace people with computers. Ray Kurzweil, another computer science visionary who got his start at MIT in the 1970s, is a prolific author of futuristic books about artificial intelligence technologies. In his 2006 book *The Singularity Is Near: When Humans Transcend Biology*, he made the prediction that humankind is moving toward a world of technological "singularity," where artificial intelligence in machines exceeds human intelligence.

We prefer the words *synergy* and *symbiosis* rather than *singularity* to discuss the meeting of the minds of human beings and computers in decision management. Decision management models are used to perform computer-based analytics and execute decisions, to modulate human bias and straight-from-the-gut thinking, to improve decisions and results. As we said earlier, the best uses of analytics come from a productive union of brain and computer power. For all the innovations and advantages in life that come from companies becoming more adept and capable of analyzing consumer data and behavior, human judgment and intuition based on expertise and experience is

a key element in the success of information-based business strategy and execution.

We will later explain how analytics and decision management go together, but before we get to that, Chapter Two presents several case studies that show how some major companies, in a variety of industries, are successfully using analytics to improve their decision-making processes—which benefits not only their customers but also their bottom line.