



# FUELING INNOVATION:

## Careers in Data Science & Analytics

A career in data science or business analytics has applications across a variety of industries. Here's a guide to the industries that are embracing it.



# MERRIMACK COLLEGE

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## Intro

The use of data analytics by private businesses, nonprofit organizations and government agencies continues to expand. No area of the workforce has been left untouched. Earning a master's degree in business analytics or data science opens the door to opportunities in almost every industry.



**Small businesses:** Access to detail data on their site's web traffic has empowered small business owners to create marketing plans that target likely future customers. They also can better meet customer demands and calculate prices for their products and services.



**Entertainment:** Netflix, Amazon and other streaming video services use data analytics to recommend content for customers, making it easier to navigate through the thousands of choices available.



**Healthcare:** Healthcare organizations are using data science and predictive analytics to identify populations most likely to develop certain medical conditions, provide better treatment recommendations for patients and reduce the rate of hospital readmissions, among other issues.



**Sports:** From the Chicago Cubs to the New England Patriots, professional sports teams have proven again and again that the application of analytics wins championships. With new tools and technology advancements, managers and owners are taking the science to a whole new level of play.



**Government:** With the Opportunity Project, the U.S. Department of Commerce seeks to bring together data experts from business, nonprofits and academia to solve real-world challenges, especially those affecting low income communities.

### THE NEW INDUSTRIAL REVOLUTION

Peter Sondergaard, a senior vice president at Gartner Research, once famously compared data and information to the last inventions that changed the world. "Information is the oil of the 21st century," he said, "and analytics is the combustion engine." But a shortage of workers skilled in data science and business analytics has slowed the adaptation of innovative technology in some areas. Businesses around the world and in many different industries are searching for talented people to fill needed data-related jobs. A master's degree separates those who earn one from the pack.

### Potential Careers in Data and Analytics

Data Scientists .....	\$128,549
Data Analyst .....	\$76,419
Information Technology Business Analyst ..	\$79,689
Functional Analysts .....	\$80,609
Research Scientist .....	\$77,028



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# 5 Ways Big Data Is Revolutionizing Manufacturing

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Big Data already has led to major changes in manufacturing. However, the process is far from over.

With advances both in the use of Big Data and the capabilities of machine learning, manufacturers continue to look for ways to leverage data analysis and improve operations.

In addition to automating many of the processes once handled by humans, manufacturers also use data analysis to understand complex manufacturing processes. This helps identify areas of improvement and leads to more efficient operations and improved products.

But what are the ways Big Data will impact manufacturing in the near future? The following seem likely answers to that question.

## Big Data Provides More Flexibility

The availability of data already has started to transform even the classic idea of a “manufacturing plant.” Many large plants now are being segmented into smaller, more flexible operations all around the world, according to Sight Machine chief executive Jon Sobel. Sight Machine is an analytics company that focuses on manufacturing. The ability to collect and communicate data is a key component in the segmenting of processes into smaller units.

### Internet of Things

Manufacturing likely stands to see the biggest gains from use of the Internet of Things (IoT). Sobel said some experts project IoT and Big Data could save manufacturers trillions of dollars over the next decade. IoT can be used in such areas as supply chain management. It also can further streamline efforts to make processes more efficient.

### Advancing Industry 4.0

The term “Industry 4.0” originated in Germany. It initially referred to a government initiative that aims to make the country a leader in

advanced manufacturing processes. Now the term encompasses all the technology advances manufacturers are using, from cyber-physical systems to cloud computing. The goal is to create “Smart Factories” that marry human worker and technological ingenuity to create the most efficient and production plants possible. Data analytics are a critical part of this initiative.

### Better Forecasts

Those in the industry told LNS Research that Big Data will eventually lead to big improvements in many areas. At the top of the list was better forecast of consumer demand, leading to better control over production and operational costs (avoiding over-production, for example). They also anticipated improved customer service using data, as well as understanding performance at a manufacturing plant across multiple metrics.

### An Explosion In Jobs

The major companies – General Electric, for example – already have made heavy investments in creating their own departments to oversee Big Data and other technology innovations. But that’s just the beginning of the job opportunities.

Many companies also contract with outside vendors for portions of their data collection and analysis. They include companies that focus on cloud computing, business process improvement systems and advanced software. This is creating an unprecedented demand for experts in data science and business analytics.

These represent just some of the ways Big Data will impact manufacturing. As factories get smarter and data reveals new insights on making improvements, the number of those entering the field will only grow.





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# Predictive Analytics Can Cut Hospitalization, Costs for Cancer Patients

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By using predictive analytics as well as risk stratification techniques, healthcare organizations have found they can reduce the number of chemotherapy-related hospitalizations.

The healthcare industry continues to find ways to use data analytics to improve patient outcomes and make organizational operations more efficient.

In recent years, one area has been in treatment of cancer patients.

The predictive analytics strategy has been used by some hospitals to reduce overall patient readmissions. By using predictive analytical modeling, patients with a likelihood of returning to the hospital – based on factors such as age and type of condition – are flagged and intervention steps are taken.

Those steps often include more frequent communication with patients. In some cases it even means the appropriate medical professionals make home visits.

The strategy for cancer-related issues follows this same course. It not only improves patient outcomes, but also opens a new area for those with data analytics degrees to put their skills to use.

## Predictive Modeling

Predictive modeling essentially assesses the probability of a future event based on input variables. In healthcare, those variables can include a wide variety of data points. Some examples of often used input variables include age, medical history, frequency of doctor and hospital visits, and clinical decisions made by medical professionals. The variables are combined with the overall data on those with conditions such as a cancer.

Medical professionals outlined much of the strategy during the 2017 Managed Care and Specialty Pharmacy annual meeting in Denver. Leaders from medical provider organizations and insurers spoke about the current use and future potential of predictive analytics and risk stratification.

Predictive modeling is also used by researchers, such as those at the University of Pennsylvania Perelman School of Medicine. They were able to determine which lung cancer patients were at a higher risk of needing treatment in an emergency department.

In the area of cancer, every case is considered high risk. However, using clinical data, analysts can identify and assess more finely grained details on the likelihood of certain events given each patient's condition and medical history.

It's essential that healthcare organizations define goals before beginning research using data sets. Reducing unnecessary costs for patients can be one such goal. Reducing the number of visits to the hospital can be another. Overall, the goal behind all data-related projects is to improve patient health outcomes.

## Three Stages of Predictive Analytics

Typically, the use of predictive analytics breaks down into three stages.

First, a predictive model is built based on the data. This usually requires a large amount of data. According to remarks at the Denver convention made by Mir T. Mimazari, assistance vice president at New Century Health, data from at least 1,000 patients is needed.

The model is based on trends found within the data on patient outcomes and costs. The model is then tested. Data is kept to see how well the model predicted patient outcomes and costs. If the model is found sufficient, it can then be moved into the validation stage.

In validation, the model is tested against new data over a set period of time. If it's accurate, then the findings can be combined with clinical treatment and decisions by medical professionals. The success of those initiatives is also tracked and changes are made as the data indicates is necessary.

In another words, as Mimazari said at the conference, it creates "a continuous learning



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## Predictive Analytics Can Cut Hospitalization, Costs for Cancer Patients (cont.)

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loop that leads to better cancer care delivery.”

He later added, “It’s not magic.”

### **Risk Stratification**

Part of the predictive analytics and modeling process involves risk stratification. It differs from the data used in modeling. Most of that data is taken from claims filed with insurance companies and patient records. However, some of this data can be months old.

In risk stratification, clinical data on what happens during treatment is collected. While not as detailed as claims data, it allows for faster action once correlations between clinical decisions and patient outcomes are found.

For example, this data can provide a quick way to identify patients who are likely to end up in the emergency room. Such visits are very predictive of future inpatient care and hospital visits. Other factors include patient age, the stage of cancer, the type of chemotherapy treatment being used and changes in a patient’s weight.

All of these factors help to calculate a “risk

score” for the patient. Medical personnel can consult this score to help guide clinical decisions.

These examples show the potential of data analytics in healthcare and how it can improve patient outcomes and reduce costs. As with most areas of the field, the strategies used are expected to change over time. They will become more detailed and streamlined as new data shows the impact of predictive analytics and modeling.



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# Big Banks Turn to Analytics to Improve Risk Management, Predict Customer Behavior

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The data analytics revolution in the business world has also reached major banks. Of all the industries tapping into the power of analytics, few have seen immediate advantages like the banking industry.

In a business governed by numbers, banking leaders have turned to data analysis in a number of key areas. These areas include predicting customer behavior, risk assessment and driving revenue.

The movement has created cost-savings for banks. It also has created yet another job market for those with degrees in data science and business analytics.

For those banks committing to analytics with time and money, analytics “can and should become a true business discipline” within banking, according to a 2017 report from McKinsey and Company.

## How Banks Benefit From Analytics

Banking turns to data science in a number of areas. Tools for business analytics have reached a level of sophistication that allows for extracting actionable conclusions from large data sets.

Some of these areas include the following.

**Risk assessment.** Banking is built on risk. Millions of data points now allow for better assessment of the risks involved in making loans and investing cash. Business analytics gives banks insights into millions of transaction as well as branch-specific information. For example, loans for a building renovation can be assessed on age of structure and geographic climate conditions as well as data on the loan applicant.

**Marketing and Sales.** Data gathered on customers helps banks better market services based on the customer’s past behavior. This helps banks predict customers’ future needs. These targeted marketing and sales efforts help to offer customers services they need rather than a “one size fits all” approach that barrages customers with every possible service.

**Performance.** Analytics can track performance of bank offices and employees in real time. For instance, data tracks goals and can help determine peak and off-peak work times, assisting banks with efforts to improve training schedules for employees.

**Regulatory compliance.** Software systems also can track various government regulations involved with banking, which change fairly frequently. Data is collected, organized and analyzed to ensure regulatory compliance.

**Cutting Costs, Increasing Profits.** As with every industry that uses analytics, proper collection and interpretation of data on day-to-day operations can lead to reducing inefficiencies and increasing profit. McKinsey’s report mentions one bank that increased profits 8 percent by analyzing discounts and eliminating those that were unnecessary. Another used analytics on customer behavior to increase customer retention by 15 percent.

## Jobs in Data For Banking

All of these areas require skilled workers in data science and business analytics.

The competition among banks for hired workers skilled in these area is “heating up,” according to Computer World. Two main areas dominate the hiring: Big Data engineers and data scientists.

The engineering group works more in designing data collection systems, whereas the second groups come from a data science and business analytics background. These groups help business leaders use conclusions from the data to make important decisions. This requires not only skills in data collection and analysis but also communication skills. Data scientists and business analysts need the ability to explain complex findings in a way that makes the data understandable for executives.

Data scientists are in the highest demand. It’s also where the largest skill shortage is present, according to Computer World.

Clearly, a degree in data science and business analytics can open the door to a stable and rapidly growing field. And one of the main areas where demand is expected to continue is in banking.



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# Moneyball for HR: Applying Data Science To Managing People

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Much like the Oakland Athletics baseball team featured in the book and movie Moneyball, businesses face a complicated task in evaluating talent and deciding if a person is the right fit for the team.

Certainly, there are tried and true measurements used by human resources managers. A personality that fits with others in the organization, for example. Or, a resume that shows success in past endeavors. Even, a college degree that shows a willingness to persevere and see something through to its completion.

But much like the old baseball scouts in the Michael Lewis Moneyball book, HR professionals are discovering that those tried-and-true methods might not produce the desired results. Especially when it comes to hiring from without or promoting from within.

Instead, data analytics is increasingly giving them insight into how to manage employees. For those earning a degree in the data analytics field, it has opened up a whole new area of opportunity.

## Medieval Thinking, says Moneyball

Much like the famous “medieval thinking” speech from Moneyball, human resource directors have decided a change is needed in how they evaluate and manage personnel.

That feeling is widespread. The 2017 Global Human Capital Trends report, conducted by analytics firm Bersin by Deloitte, found that 90 percent of HR managers feel they need “to re-engineer their entire organizational model. That involves rethinking leadership, management, careers and jobs,” according to company founder Josh Bersin.

Known as “people analytics,” the movement in HR to incorporate analytics into a company’s personnel management seeks to refine how jobs are filled. It also seeks to replace older methods such as intuition or networking with measurable metrics.

Writing about the topic, Washington Post columnist Steven Pearlstein used Baltimore entrepreneur Michael Rosenbaum as an example. In choosing software programmers for his company, Rosenbaum paid no attention to whether his students had graduated from big-name schools.

The reason? Statistics showed no correlation between job performance and where a person got a degree.

## The Need For Change

In that same column, Pearlstein referred to surveys from the Corporate Executive Board and Gallup. They found, respectively, that a quarter of new hires leave within a year. And furthermore, that of those who stay, 50 percent report not being engaged with their job.

Some of the new, data-driven ways of thinking have shown that conventional wisdom hasn’t been all that wise. This was true in both hiring practices and in promotional decisions. Using quantitative metrics – the number of sales closed by a salesperson, for example, or the number of projects successfully completed – data analysts’ discovered the following:

- Time on the job does not necessarily translate into success in the future
- Statistics do not support the notion that it’s a bad idea to hire a convicted felon, someone who changes jobs frequently or someone who is unemployed
- Other factors prove more useful in predicting a person’s performance, such as how far they have to drive to work
- According to the Society For Human Resource Management (SHRM), HR managers and business executives are often not asking the right questions.

For example, SHRM suggests questions such as “what part of a training program led to business success” and “what words appear the most on the resumes of successful employees” as examples of inquiries that, though analyzing large amounts of data, can give a company a better idea of future performance.





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# Moneyball for HR: Applying Data Science To Managing People (cont.)

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## **What HR Needs**

For those interested in applying their data analytics degree to human resources, it's helpful to know more about what companies want. SHRM listed the following qualities HR leaders would want if they could create their own data analysts. They included the following:

**Statistics and storytelling.** Data analysts need to know the finely grained details of extracting useful information from large data sets. But, they also need the skills to communicate that information to executives.

**Business sense.** Data analysts need a strong foundation in how a company operates and the factors that led to making a profit. Or, as the case may be, not making a profit.

**Collaboration.** Extracting and interpreting data is one thing, but analysts also must have the people skills to collaborate with others.

**HR knowledge.** Data analysts will never know how to ask the right questions if they don't have a sound knowledge of the drivers behind attracting and retaining employees. They also need a general knowledge of performance management.

Opportunities await skilled data analysts who have received a quality education and can commit to working in the relatively new area of "people analytics." Clearly they have a role to play in a new approach to managing human resources.

As Lewis wrote in Moneyball, people "operate with beliefs and biases. To the extent that you can eliminate both and replace them with data, you gain a clear advantage."



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# Using Data to Predict the Next Hollywood Blockbuster

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The Hollywood movie industry expects to make \$35.3 billion by 2019. By any measure, that is incredible success.

But data might provide movie producers a way to do better. Much better.

Hollywood currently operates on a system in which movie executives green light projects they feel will have a market. That can range from summer blockbusters to smaller, independent films.

It's the blockbusters that help overcome box office bombs. Movie studios need them. That's because for every Harry Potter or Batman movie that becomes a hit, there is a "Lone Ranger" or "Catwoman" that does not.

Hollywood increasingly is interested in using data to better give viewers what they want. It also can optimize marketing efforts to help reach the right audience.

## Uses of Data in Hollywood

There are two key areas many areas where data can help with both making movies and marketing them.

### Real-Time Reaction

Internet sites such as the Internet Movie Database provide tons of data on consumers' reactions to movies. With its anonymous nature, the site provides a wealth of raw reaction to films. Looking at such sites as well as social media also generates feedback that goes beyond age-old demographics.

IBM's Richard Maraschi told The Atlantic that movie studios still group audiences into large segments such as over and under 25. He feels collecting data from online reactions can drive better results for studios. He noted that such data gives a finely grained look at movie audiences, such as "soccer moms in Florida that are really passionate about action films."

### Marketing

Movie marketing remains mass market. However, some studios have moved into using data from past movie reactions to market toward niche groups. An example is Legendary Entertainment. The company is behind the "World of Warcraft" movies, and has used a data-driven approach to marketing.

The company's chief analytics officer, Matt Marolda, told the Boston Globe that the company wanted to target gamers. They also wanted to avoid people who had no interest in the film who would respond negatively to advertising. They did so by targeting online marketing to gamer sites.

### The Netflix Method

Netflix started as a digital streaming company for movies and television shows. The company now makes its own films using a data-driven strategy. It won't be surprising if they eventually produce major movie blockbusters.

Netflix has enormous amounts of data at its disposal. It goes far beyond what movies are the most popular and what ratings people give them.

Some of the data Netflix collects includes what days of the week people watch television and when they watch movies. They know at what point people paused a movie or hit fast forward. They know which show in a TV series is the one that a majority of people bail out on and never finish the series. They know how fast people binge-watch different kinds of television series.

They even used data to develop the hit television show "House of Cards." They picked director David Fincher because his movies are popular and often watched all the way to the end. They picked Kevin Spacey because he remains popular no matter what genre he stars in. And they remade the British series "House of Cards" because the original had proven popular with viewers.

It became the most streamed television show in the U.S. and 40 other countries.

Clearly, data is the future for Hollywood. Netflix and Amazon, another data-driven company, have access to information beyond what traditional media companies have. But ideas such as the one from IBM on data collection will increasingly drive decisions.

And based on how good television series offerings have gotten on Netflix and Amazon, everyone can also hope it will lead to better movies.



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# The Job Explosion in Operations Research Analysis

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Companies today rely on data as a driver for innovation and decision-making. That has led to a growth in jobs for data scientists across many different careers.

One of the biggest job growth areas is operations research analysis. Organizations need employees with knowledge in analytics to solve complex issues. They also identify areas where data can make operations more efficient.

It's a career field that offers stability and growth for those with a data science degree.

## 30% Growth for Operations Research Analysis

The federal Bureau of Labor Statistics (BLS) is the primary source for statistics and projections related to jobs in the United States. The BLS ranks operations research analyst among the hottest jobs in the country.

The BLS projects the average rate of job growth between 2014 and 2024 for all professions at about 8 percent. That number is **30%** for operations research analysts.

Almost 28,000 new jobs are expected in the field. That will raise the total number of operations research analyst jobs to almost 119,000.

The popularity of the professions comes with substantial pay. The BLS reported a median salary of \$79,200 for operations research analysts in May 2016. The top 10 % in the job earned \$132,660.

Jobs also are available in both the public and private sectors. Those working for the federal government made a median salary of \$109,770 in May 2016, according to the BLS. Operations research analysts also worked in manufacturing, finance, insurance and for technology and scientific organizations.

### What Operations Research Analysts Do

The jobs duties for an operations research analyst can vary from industry to industry. Different departments within organizations

also have different needs. However, the following job duties are typical in this field. Identifying areas of improvement. Regardless of industry, analysts work on complex problems that have an impact on a variety or areas of an organization or business. Examples include improving communications among healthcare workers in different departments at a hospital or identifying target consumer demographic groups for marketing campaigns.

**Collecting data.** Analysts develop systems to properly collect data, often from disparate systems. A challenge they often face is bringing together massive amounts of data, with differing formats, from a wide variety of sources so that it can be used in a meaningful way.

**Analyzing Data.** Analysts use proven methods to interpret data and make recommendations for action. This can include simulations, predictive modeling and statistical interpretation.

**Determining Focus.** Companies now have more data than ever in history to use for making decisions. One of the biggest problems business leaders face is knowing what data to consider. Data scientists bring expertise to the table in determining not only what to consider but also the data to ignore.

### Getting Into the Profession

Innovations in technology and data analysis has led to universities offering a variety of data-related degrees. Qualifying for entry-level jobs in operations research analysis requires a bachelor's degree. Typical coursework revolves around extensive education in mathematics and computer science.

Higher level jobs require a master's degree. That is why many universities now offer degree programs at the master's level in data science. Some, such as Merrimack College, offer online degree programs in data science. Such programs allow students to better schedule classwork around their personal and professional lives.



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## The Job Explosion in Operations Research Analysis (cont.)

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Master degree programs in data science can vary in terms of curriculum and focus. Merrimack College focuses more on application of data science to real-world challenges. Students gain experience in data management, statistical analysis, predictive modeling, machine learning and data visualization.

Advancement in technology has dramatically changed the way organizations make decisions. With these innovations expected to

continue in the coming years, organizations need people with the skills to understand how to leverage technology and utilize the data that is now so readily available. Because of this, the job trend in operations research analysis should continue as well. It provides yet another meaningful career opportunity for those with degrees in data science.



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# How Data Science and Analytics are Changing Competitive Sports

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The biggest change in competitive professional sports this century has not taken place on the field, but in the front office. Specifically in the use of data science and analytics to win games.

Once, general managers focused primarily on hiring talented players and bringing in coaches who excelled at player management and on-field strategy. And, guess what? That's all still important. However, the methods used to evaluate those players and coaches have changed. The rise of data science and analytics, along with the ability to measure and utilize patterns found in data research has altered how teams evaluate players and develop on-field strategies.

## Data Science and Analytics in Sports

It's also opened the door to hundreds of jobs for those with a degree in data science and analytics. Sports team owners now realize the same talented people they hire for their businesses are the same people they want in the front offices of their sports teams.

Billy Beane, executive vice president of baseball operations for the Oakland Athletics, wrote in the Wall Street Journal that advanced technology stills needs the right people who know what data to collect and how to interpret it.

This will "dramatically change" the composition and demographics of front offices, which historically have drawn on former players.

"Competing to hire those best equipped to glean insights from the new data regardless of their backgrounds will be a welcome trend in an industry that has actively sought ways to improve its diversity," says Beane.

### Beane and the Oakland A's

Beane served as general manager for the A's baseball team in 2002. He already had learned how to apply analytics to evaluating players, but in 2002 he went a step further by hiring statistician Paul Depodesta, a Harvard graduate.

Like many businesses who turn to data science and analytics, the A's were looking to cut costs while finding ways to maintain a quality product. Beane and the A's have had their ups and downs, but no one will argue that they haven't done well overall. Even better, in some cases, than teams that have spent far more money.

The Boston Red Sox and Chicago Cubs have won championships by using many of the same approaches. The primary difference in both cases being that those clubs had more money at their disposal. But both used data-driven strategies that paid off.

Many teams are now following suit. The low-budget Tampa Bay Rays were an early adopter of analytics. The Houston Astros, after hiring an analytics-driven general manager and a NASA engineer, have had a complete rebuild of the team that resulted in four losing seasons. But now the team is a contender. The Chicago White Sox, San Diego Padres, Milwaukee Brewers and Cincinnati Reds have all followed suit, with varying degrees of analytics buy-in.

### The Rise of Data Science and Analytics

Data analytics even continues to spread to other sports. The National Football League's Cleveland Browns hired DePodesta to run the team with an analytics approach. This team is currently in a rebuild phase.

And while no one really knows what the New England Patriots do, owner Robert Kraft is a big proponent of data science and analytics. They've had economics expert and former bond trader Ernie Adams on their staff from the beginning of the Bill Belichick era.

What all this means is that someone earning a master's degree in data analytics might have just as much chance working for a sports franchise than working in finance, healthcare or marketing.

### The Use of Data

While data can be used for a variety of purposes, the two main areas are: Finding the true value of a player and making better on-field decisions.





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## How Data Science and Analytics are Changing Competitive Sports (cont.)

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Using baseball as an example, data analytics have led to you seeing very different things when you watch a game. They include:

- Batters taking more pitches, looking to get pitch-counts up and also waiting for the best possible ball to hit. As explained in the Michael Lewis book "Moneyball," each at bat is like a hand of black jack, with the odds changing on each pitch.
- Defenses shifting their positions in the field – sometimes radically – to place themselves where statistics show the batter is most likely to hit the ball
- Less bunting and stealing, which statistics show help a team a lot less than people might think
- There are some 20 different data points for every pitch thrown, and this is affecting arm angle, release point and also strategy for where to place pitches, depending on the hitter

Player evaluation is even more complicated. Once measurements such as 60-yard dash speed and batting average were important. Now, it's numbers like on-base percentage plus slugging percentage and win share (calculating a player's individual contribution to a win) that are factors.

Beane and others expect data to reach a point where general managers can determine what combination of players work best, rather than just focusing on individual statistics.

All of this requires experts in data science and analytics. Increasingly, those doing the hiring want employees to have advanced degrees, giving them the latest knowledge and skills. And as the NFL and NBA move more into this area, look for the job market to grow even larger.



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# How NBA Analytics is Changing Basketball

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Like other professional sports NBA analytics are taking shape on the professional basketball court.

Major League Baseball's last two champions, the Chicago Cubs and the Houston Astros, both are led by front offices with a strong emphasis on using data analytics.

The National Football League has the New England Patriots, who use analytics but play things so close to the vest that no one is exactly sure what they are doing.

The NBA also has gone into analytics in a big way. Almost every team now has an NBA analytics department in the front office. Data is collected using cameras that record every movement of both the ball and all 10 players 25 times per second.

Here are some of the ways teams are leveraging data analytics to become more competitive.

## Using NBA Analytics to Rest Players

Teams now pay a great deal more attention to fatigued players in the NBA for a variety of reasons.

One is fairly obvious. Resting a player during a relatively meaningless game late in a season makes more sense than having him take the court in the playoffs without the energy he needs to be at the top of his game.

The other is injuries. Players tend to get hurt more often when they play fatigued, according to the data from thousands of injuries.

At an analytics conference this year, NBA commissioner Adam Silver said teams now have players wear monitor not only during games but during practice to measure, in part, performance and fatigue. They even have saliva sampled as it contains indicators of fatigue. Teams track and quantify a player's diet.

All of this works toward having a better, healthier player and a better basketball team.

## Using NBA Analytics to Pick Players

In the same speech, Silver contrasted what a sports team faces in picking players against what a Fortune 500 company faces in making an important hire for a critical job.

For the company, things work out or they don't in a fairly accelerated time frame. It doesn't take years for executives to realize whether a person is right for the job or not. If things don't work out, the employee is simply let go and another person is hired to take the position.

While NBA teams have some flexibility in filling key roles with free agents, much of a team is built through the draft. A wrong choice in the first round can set a team back years. Teams look for whatever advantage they can when evaluating picks, and analytics play a key role.

Data from college and high school play is analyzed. Performance in matchups against certain types of players is quantified. "The number of analytics fields they're looking at now, for example when they're doing college scouting or drafting internationally, is incredible," Silver said.

## NBA Analytics and Scoring

Nothing shows fans what analytics have brought to basketball more than the explosion in attempts for three-point shots. In 2012, teams averaged about 18 three-point attempts per game. In 2017, that number reached 27.

Why? It's really just common sense and math, backed up by data. Essentially, data showed that the reward of taking a three-point shot outweighed the risk. On average, teams that take more three-point shots ultimately score more points over the course of a game.

The Golden State Warriors, the current champions of the league, are a perfect example of this philosophy.

## NBA Analytics and Matchups

Teams also crunch large data sets on defenders for other teams. They determine



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## How NBA Analytics is Changing Basketball (cont.)

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where they had the most and least amount of success against various offensive attacks, such as long range shots, midrange jumpers and driving the lane to the basket.

Teams then take that information to isolate a player who is good in one area against a defender who isn't. The flipside is true, as well. Teams attempt to get their defenders on a specific player, particularly in critical situations, if that defender has a statistically better chance of preventing a score.

These are just some of the area where data analytics is changing the NBA in fundamental ways. The revolution is still in its earliest stages, but it has opened up an entire new career path for those who wish to go into analytics.



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# Is Data Analytics the Secret Weapon of the New England Patriots? Maybe

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The success of the New England Patriots has led to joy for the team's many fans. But it also has led to a big question among those who closely follow the game.

In short, how in the world are they doing this?

Yes, they have a great quarterback in Tom Brady. But plenty of teams have had a great quarterback without the track record of the New England Patriots. Consider some of their accomplishments.

- The Patriots have gone to six straight conference championships
- They have gone to seven Super Bowls since 2001, winning five of them
- They have had a winning record in 16 straight seasons
- They've gone to the playoffs in 14 of the last 16 seasons

The only teams with that sort of record are the Dallas Cowboys from 1966 to 1985. That team, coached by Tom Landry, made the playoffs in 18 out of 20 seasons. They went to the Super Bowl five times, winning twice.

The Cowboys of that era also were pioneers in the use of data analysis for both picking players and in-game strategy.

Is that also the secret weapon of the New England Patriots?

## New England Patriots Play Close To The Vest

The Patriots – much like the Cowboys in the Landry era – play their cards close to the vest. No one is quite sure how they evaluate players or make strategic decisions. It's just clear that whatever they are doing, it's working. Very well.

What is known is that the team brought on Ernie Adams, a former data-driven Wall Street trader, from the outset of the Bill Belichick era. Belichick has coached the team since 2000.

Also, Patriots owner Robert Kraft also owns an analytics company, the Kraft Analytics Group. The New England Patriots are listed as a partner. While it shows an interest in data analytics, company's focus is on marketing and operations research.

More importantly, those who watch analytics closely have followed the Patriots with great interest. "They're completely consistent with what sophisticated analytics would tell you to do," an anonymous "long-time NFL exec" told Sports Illustrated.

Of course, the one-man genius theory continues to be an option. In the very same Sports Illustrated article about data analytics in the NFL, another anonymous NFL team executive claims that Belichick makes decisions with an "intuition" that matches the most advanced analytical tools.

He is compared to Bill Walsh, the late coach of the San Francisco 49ers, who created a new style offense to elevate the team to three championships in the 1980s.

## Staying Ahead

The Patriots have made many moves that keep them ahead in the highly competitive NFL. With every team operating under a salary cap, the playing field is theoretically level. But in reality, it's not. Certain teams have remained consistently good over the past decade. The Patriots rank first among this group.

This in an era where most teams have subscribed to data analytics services that provide breakdowns of every game. One possible difference is that the Patriots leverage the data in positive ways, while other teams either don't do that or even ignore the data.

Here are some of the moves the Patriots consistently make.

**Dealing middle round draft picks.** Over and over, the Patriots have dealt fourth or fifth round draft picks to other teams in exchange for veterans. Essentially, they are trading an unproven player not among the top rankings of college players for a guy who already has



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## Is Data Analytics the Secret Weapon of the New England Patriots? Maybe (cont.)

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shown worth in the NFL. Not flashy, but effective.

**Cutting expensive players.** They will let go players, even in their prime, who have become too expensive. This is part of managing the team budget. Examples would include defensive back Lawyer Malloy and defensive tackle Vince Wilfork.

**Invest in the middle.** It's logical to attack an enemy in their weakest area. Data analysis backs up that strategy. In the context of football – why invest in super expensive receivers who go up against the other team's best defensive backs? A better strategy is to secure dependable slot receivers and running backs who can catch the ball. They typically work the middle of the field, matching up against the weaker pass coverage personnel on the defense.

**Rotating running backs.** The Patriots have had good, solid running backs. But they make frequent changes at this position and do not over-invest in the position. From a percentage point of view, this has better odds of succeeding than investing heavily in one running back. Teams that do that are often one injury away from having a lost season.

Other teams do these things, but not all of them, all of the time. The Patriots have been remarkably consistent with these strategies.

Much of it, according to experts, aligns with an advanced, data-driven approach to running a football club. Do the New England Patriots take this approach? It certainly seems likely.

Or Bill Belichick is a football savant.

Maybe a bit of both.





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# The Latest Data Analytics Tools in Baseball

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Data analytics often proves a tough concept for people to grasp. However, one sport has helped many people understand the power behind interpreting large sets of information: Major League Baseball.

Baseball is the oldest professional sport in the United States. The game provides a treasure trove of data for both sports historians looking at trends and current teams looking for a competitive edge.

Part of the allure is the sheer size of available data. Major League Baseball has been in existence since 1903. That's 114 years of baseball and more than 200,000 games.

That's a great data set for looking at overall trends. But baseball teams also now use data to make decisions within the games themselves. To do so, they use many different tools and analytical approaches to track important in-game information.

This approach has helped teams such as the Chicago Cubs and Boston Red Sox win championships. They've also helped smaller-market clubs such as the Tampa Bay Rays, Oakland Athletics and Pittsburgh Pirates remain competitive.

And it has opened up a whole new career field for those who want to earn a data analytics degree.

## Data Analytics Tools

Scour the Internet for hours. Call all 30 Major League clubs. Read a book or two about data analytics in baseball. Even with all that, the secrets of baseball analytics will remain secret. With every club now committed at some level to analytics, no one wants to talk about exactly what they are doing.

Still, some things are known. And it involves a level of analysis unrivaled in sports.

### Collecting Data

Teams use high-resolution cameras to capture dozens of data points during a game. These include:

- A player's base-to-base running speed

- Pitching velocity
- Exit velocity of home runs
- Pinpointing where every batted ball lands
- Pinpointing the position from which a fielder moves to catch a ball traveling to another point (and whether it's success or a failure)
- The spin of each pitched ball
- The location of each pitched ball
- The pitcher's arm angle
- The position of every defensive player on every pitch

Teams get reports every morning from Statcast, the MLB-owned data service that provides teams with play-by-play statistics. Most teams also seek outside information to get an edge on other franchises.

These analytical tools include Trackman, which offers finely grained information on pitchers. That includes the spin rate of the ball and the exact height and angle of the pitch release point.

This has spilled over to the fan experience as well. Anyone watching a game on TV has seen PITCHf/x, which provides a grid showing where a pitch landed in or out of the strike zone. It also provides velocity and movement information for each pitch.

But all of that is just the start.

### Interpreting Data

As any data analytics student knows, collection is just the first step. While it's important to have strict guidelines on collection, it's equally important to have a strategy on approaching data analysis.

Give a class of analytics students data from an entire baseball season and they will all come up with different interpretations and strategies. The same is true of the 30 Major League clubs.

In baseball, it has led to defensive shifts that



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## The Latest Data Analytics Tools in Baseball (cont.)

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match where data says a batter usually hits a ball. It also has led to batters changing their swings to get more lift on the ball. Data shows a ball hit the air is typically more productive than one hit on the ground.

It also has led statisticians to develop a whole range of new barometers to assess a player's performance. Gone are the days of judging pitchers on ERA and batters on batting average. The new measurements include:

### **ERA+**

Earned run average is calculated by taking the total number of earned runs allowed multiplied by nine and divided by innings pitched. However, ERA+ includes factors such as ballpark dimensions.

### **Fielding Independent Pitching**

Fielding Independent Pitching is expressed like an ERA, but solely factors events pitchers can control. That includes home runs allowed, walks and strikeouts. This prevents pitchers from getting credit for runs prevented by the defense behind him.

### **On-Base Plus Slugging**

The OPS combines the percentage of time a batter gets on base with slugging, which is the total number of bases a player reaches with a hit divided by at-bats. Elite players have an OPS of .900 and above.

### **Wins Above Replacement**

This measurement involves a complex formula used to judge how many wins a player contributes to in comparison to what an average player contributes.

All of the above explains why many teams now have large and growing staffs of data analysts. For those who want to earn a degree in data analysis, baseball has opened up a whole new area of employment opportunity.



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# Success of Red Sox, Cubs Shows Power of Analytics in Baseball

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After Theo Epstein's run as general manager with the Boston Red Sox, some critics remained unconvinced of the power of analytics in baseball.

No matter that the Red Sox won the 2004 World Series under Epstein, the team's first championship since 1918. Then, they won another under Epstein's management in 2007.

In 2011, Epstein became president of baseball operations for the Chicago Cubs. Unlike Boston, the Cubs were a bottom of the division team when Epstein took over. By 2016, they had won their first World Series in 108 years.

As in Boston, Epstein took a data-driven approach to running the Cubs.

"The great analytics war ended end at 48 minutes after midnight on Nov. 3, 2016," wrote sports site The Ringer. That's when the Cubs pulled out a thrilling Game 7 World Series victory over the Cleveland Indians.

For those interested in data analytics, it was a night to remember.

## Data Revolution

The revolution for analytics in baseball started with Bill James' publication of "statistical abstracts" on the game from 1977 to 1988. James went beyond such well-known measurements as batting average and earned run average, delving into more sophisticated ways of judging players. He coined the term *sabermetrics* to describe his efforts.

Some of his empirical analysis resulted in new measurements. On-base percentage accounted for how often a player reached base, whether by a hit, walk or getting hit by a pitch. Slugging percentage calculates the total number of bases reached by a hitter and divides by the number of at-bats.

Both have proven a better barometer of a player than batting average, which simply divides hits by numbers of at bats.

And that was just the beginning. Eventually, Billy Beane and the Oakland Athletics brought James' ideas onto the field in the early 21st century, as documented in "Moneyball." The team used advanced metrics to get a better understanding of the value of a player.

Both the "Moneyball" book by Michael Lewis and the film starring Brad Pitt offer data analytics students and professionals a glimpse into the difficulties of selling data-driven strategies to entrenched veterans who are comfortable with long-held philosophies.

Data can make a team better. But that's not always the way others view it.

Baseball provides a great example of this in action.

## Analytics in Baseball After the Red Sox

Even after Epstein proved the value of a data-driven approach to baseball in Boston, other teams were reluctant. Some on the St. Louis Cardinals staff gave data-driven general manager Jeff Luhnow a difficult time because of his new ideas on evaluating players.

He's now with the Houston Astros and has built a winner using a data-driven approach to analytics in baseball.

In fact, every professional baseball organization now has an analytics person on staff. Some have whole teams.

However, whether individual teams actually put data-derived strategies into action is the source of debate. But the Cubs and Red Sox clearly do. It's not a surprise that in the final month of the season, both teams look to make the playoffs again.

No team will discuss exactly how they use data. The competition is that fierce. But attentive fans can't help but notice that numbers must be behind certain deals.

For example, take the first trade Epstein made as GM of the Red Sox. He traded superstar Nomar Garciaparra to shore up the team's defense. At the time, media coverage focused



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## Success of Red Sox, Cubs Shows Power of Analytics in Baseball (cont.)

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on the sudden trade of the team's best player. But Epstein knew the team could not win with a poor defense.

He said straightforwardly, "We weren't going to win a World Series with our defense." The newly structured team won the World Series that year.

Epstein also famously told Cubs ownership that the team would be ready to compete for a championship in 2016. Five years later, that's the year they won it all.

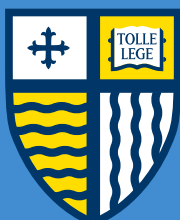
Many are watching closely as data-driven teams seem on a collision course in the playoffs. The Los Angeles Dodgers are led by

Andrew Friedman and Farhan Zaidi, who used unconventional analytics to build winners in Tampa Bay and Oakland, respectively.

The Cubs, Red Sox and Astros also all seem destined for the playoffs.

What does the future hold? Both sports fans and those interested in analytics will be watching.





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