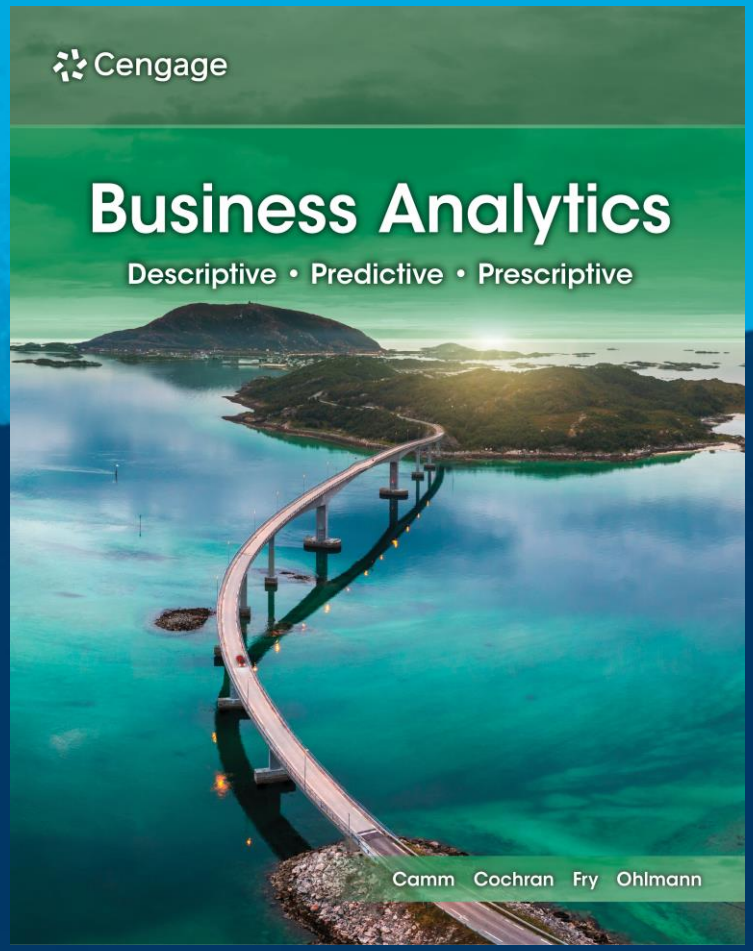

Business Analytics, 5e

Chapter 1 – Introduction to Business Analytics

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Chapter Contents

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Learning Objectives

After completing this chapter, you will be able to:

LO 1-1 Identify strategic, tactical, and operational decisions.

LO 1-2 Describe the steps in the decision-making process.

LO 1-3 Identify examples of descriptive, predictive, and prescriptive analytics.

LO 1-4 Describe applications of analytics for decision making.

Introduction

The purpose of this book is to provide

- a sound conceptual understanding of the role that business analytics plays in the decision-making process, and
- a better understanding of successful applications of analytical methods.

Three developments spurred recent explosive growth in the use of analytical methods in business applications.

1. The tracking and storing of large amounts of data.
2. Methodological developments to extract knowledge from data.
3. An explosion in computing power.

1.1 Managers' Responsibilities in Decision Making

Strategic decisions involve higher-level issues concerned with the overall direction of the organization.

- Define the organization's overall goals and aspirations for the future.

Tactical decisions concern how the organization should achieve the goals and objectives set by its strategy.

- Usually the responsibility of midlevel management.

Operational decisions affect how the firm is run from day to day.

- The domain of operations managers, who are the closest to the customer.

1.1 The Decision-Making Process

The following five steps define the decision-making process:

1. Identify and define the problem.
2. Determine the criteria that will be used to evaluate alternative solutions.
3. Determine the set of alternative solutions.
4. Evaluate the alternatives.
5. Choose an alternative.

Common approaches to making decisions include

- tradition
- intuition
- rules of thumb
- using the relevant data available

1.2 Business Analytics Defined

Business analytics is the scientific process of transforming data into insight for making better decisions.

- The use of data-driven or fact-based decision making is often seen as more objective than other decision-making alternatives.

Tools of business analytics can aid in decision making by

- creating insights from data,
- improving our ability to forecast for planning more accurately,
- helping us quantify risk, and
- yielding better alternatives through analysis and optimization.

1.3 Descriptive Analytics

Descriptive analytics encompasses the set of techniques that describes what has happened in the past.

Descriptive analytics techniques include

- data queries
- reports
- descriptive statistics
- data visualization (including data dashboards)
- unsupervised learning techniques from data mining
- basic spreadsheet models

1.3 Examples of Descriptive Analytics Techniques

A **data query** requests information with certain characteristics from a database.

- A **report** resulting from a query may include descriptive statistics and data visualizations to find patterns or relationships in a large database.

Data dashboards are collections of tables, charts, maps, and summary statistics updated as new data becomes available.

Data mining unsupervised learning techniques.

- An **unsupervised learning** technique is a descriptive method that seeks to identify patterns in different types of data that are based on notions of
  - similarity (cluster analysis)
  - correlation (association rules)

1.3 Predictive Analytics

Predictive analytics consists of techniques that use models constructed from past data to predict the future or ascertain the impact of one variable on another.

Predictive analytics includes

- linear regression and time series analysis,
- data mining supervised learning techniques,
  - **Supervised learning** techniques use past data to find patterns or relationships among data elements in a large database.
- **simulation**, which involves using probability and statistics to construct a computer model to study the impact of uncertainty on a decision.

1.3 Prescriptive Analytics

Prescriptive analytics indicates a course of action to take.

- A predictive model provides a forecast or prediction, not a decision.
- A prescriptive model is a predictive model combined with a rule.
- Prescriptive models that rely on a rule or set of rules are often called **rule-based models**.

Other examples of prescriptive analytics are

- portfolio models in finance,
- supply network design models in operations, and
- price-markdown models in retailing.

1.3 Examples of Prescriptive Analytics Techniques

Models that give the best decision subject to the constraints of the situation are known as **optimization models**.

Simulation optimization combines probability and statistics to model uncertainty with optimization techniques and find good decisions in highly complex and uncertain settings.

Decision analysis is used to develop an optimal strategy when a decision maker faces several decision alternatives and an uncertain set of future events.

- **Utility theory** is a branch of decision analysis that assigns values to outcomes based on the decision maker's attitude toward risk.

1.3 Coverage of Business Analytics in This Text

Chapter	Title	Descriptive	Predictive	Prescriptive
1	Introduction	●	●	●
2	Descriptive Statistics	●		
3	Data Visualization	●		
4	Data Wrangling	●		
5	Probability: An Introduction to Modeling Uncertainty	●		
6	Descriptive Data Mining	●		
7	Statistical Inference	●		
8	Linear Regression		●	
9	Time Series & Forecasting		●	
10	Predictive Data Mining: Regression Tasks		●	
11	Predictive Data Mining: Classification Tasks		●	
12	Spreadsheet Models	●	●	●
13	Monte Carlo Simulation		●	●
14	Linear Optimization Models			●
15	Integer Optimization Models			●
16	Nonlinear Optimization Models			●
17	Decision Analysis			●

1.4 Big Data

Big data is any set of data that is too large or too complex to be handled by standard data-processing techniques and typical desktop software.

IBM describes the phenomenon of big data through the four Vs:

- volume, velocity, variety, and veracity (see next slide.)

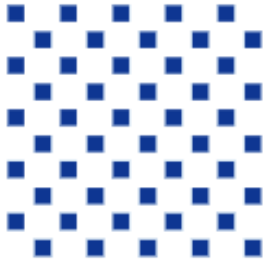
The challenges of big data, in terms of data storage and processing, security, and available analytical talent, led to the development of new technologies:

- **Hadoop** is an open-source programming environment that supports big data processing through distributed storage and cloud computing.
- **MapReduce** is a programming model used within Hadoop that performs two major steps: the map step and the reduce step.

1.4 The Four Vs of Big Data

Volume

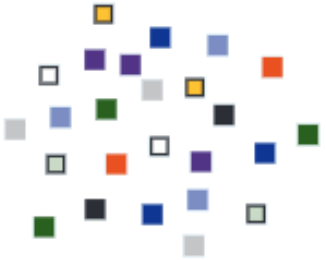
Data at Rest



Terabytes to exabytes of existing data to process

Variety

Data in Many Forms



Structured, unstructured, text, multimedia

Velocity

Data in Motion

Streaming data, milliseconds to seconds to respond

Veracity

Data in Doubt

Uncertainty due to data inconsistency and incompleteness, ambiguities, latency, deception, model approximations

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1.4 Cloud Computing and Data Security

The massive amounts of available data have led to numerous innovations that help make the data useful for decision-making.

- **Cloud computing** (“the cloud”) refers to the use of data and software on servers housed externally to an organization via the internet.
- The cloud has made storing and processing massive amounts of data feasible and cost-effective.

The security of highly confidential data stored on the cloud is critical to companies and must be protected from hackers.

- **Data security** protects stored data from destructive forces or unauthorized users.

1.4 Artificial Intelligence and Data Scientists

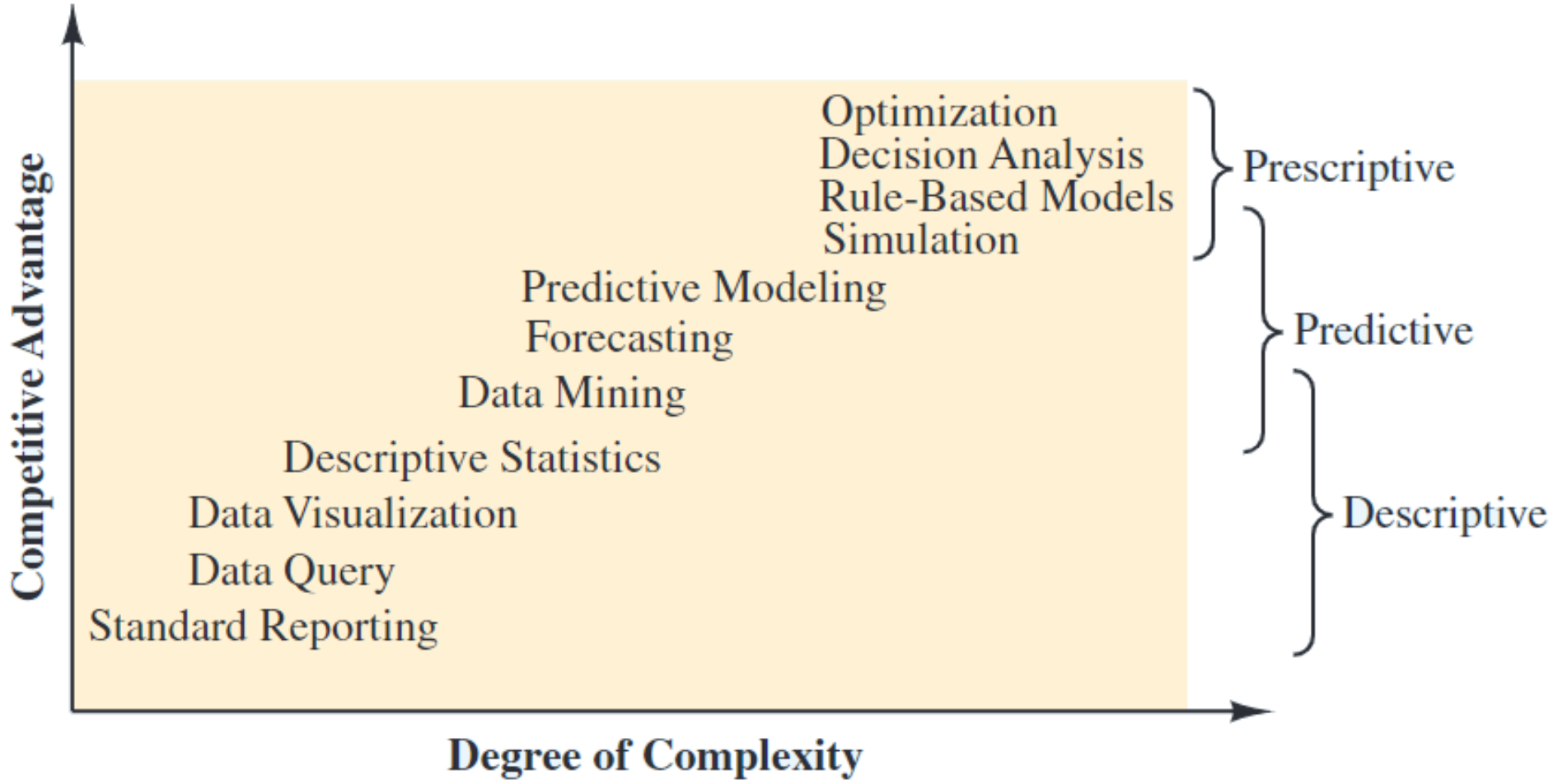
Big data has also accelerated the development of applications for artificial intelligence.

- **Artificial intelligence** (AI) uses big data and computers to make decisions that would have required human intelligence in the past.
- Applications of AI include facial recognition for security checkpoints and self-driving vehicles.

The complexities of big data have increased the demand for analysts and created challenges due to a shortage of qualified new hires.

- **Data scientists** are analysts trained in computer science and statistics who know how to process and analyze massive amounts of data.

1.5 The Spectrum of Business Analytics



1.5 Financial Analytics

The financial services sector relies heavily on descriptive, predictive, and prescriptive analytics.

- Descriptive analytics, through data visualization, is used to monitor financial performance, including stock returns, trading volumes, and measures of market return and volatility.
- Predictive models are used to forecast financial performance, assess the risk of investment portfolios and projects, and construct financial instruments such as derivatives.
- Prescriptive models are used to construct optimal portfolios of investments, allocate assets, and create optimal capital budgeting plans.

1.5 Human Resources (HR) Analytics

The HR function is charged with ensuring that the organization

1. has the mix of skill sets necessary to meet its needs,
2. hires the highest-quality talent and provides an environment to retain it,
3. achieves its organizational diversity goals.

Google uses “people analytics” to analyze data on its employees to

- determine the characteristics of great leaders, assess factors contributing to productivity, and evaluate potential new hires.
- Google also uses predictive analytics to continually update its forecast of future employee turnover and retention.

1.5 Marketing Analytics

Marketing is one of the fastest-growing areas for the application of analytics.

- The use of scanner data and data generated from social media has led to a better understanding of consumer behavior and increased interest in marketing analytics.
- As a result, descriptive, predictive, and prescriptive analytics are all heavily used in marketing.

Predictive models and optimization are used to better align advertising to specific target audiences making marketing efforts more effective and efficient.

Sentiment analysis allows companies to monitor better “the voice of the customer” and use the data to adjust their services and products.

1.5 Health Care Analytics

The use of analytics in health care is increasing because of pressure to control costs and provide more effective treatment simultaneously.

Descriptive, predictive, and prescriptive analytics are used to improve

- patient, staff, and facility scheduling,
- patient flow,
- purchasing, and
- inventory control.

The use of prescriptive analytics for diagnosis and treatment is the most critical application of analytics in health care.

1.5 Supply-Chain Analytics

Analytics has long been used to achieve the efficient delivery of goods: the core service of logistic companies.

- To UPS and FedEx, the optimal sorting of goods, vehicle and staff scheduling, and vehicle routing are all key to profitability.

Supply chain problems caused by the COVID-19 pandemic and world conflicts focused on using analytics to increase the resiliency of the supply chain.

- Descriptive analytics is used to monitor supply chain performance.
- Predictive analytics is used to quantify risk.
- Prescriptive analytics with scenario analysis is used to prepare supply chain solutions that can handle a high degree of disruption.

1.5 Analytics for Government and Nonprofit Agencies

Government agencies use analytics to increase the effectiveness and accountability of programs.

- The U.S. Internal Revenue Service uses data mining to identify patterns that distinguish questionable annual personal income tax filings.

Likewise, nonprofit agencies use analytics to ensure their effectiveness and accountability to donors and clients.

- Descriptive and predictive analytics monitor agency performance, track donor behavior, and forecast donations.
- Data mining helps identify potential donors and minimize donor attrition.
- Optimization allocates scarce resources in capital budgeting.

1.5 Sports Analytics

Professional sports teams use analytics to

- assess players for the amateur drafts,
- decide how much to offer players in contract negotiations, and
- assist with on-field decisions.

Sports franchises also use analytics for off-the-field business decisions.

- Based on fan survey data, a predictive technique known as conjoint analysis is used to design stadium premium seating.
- Prescriptive analytics is used to adjust ticket prices throughout the season dynamically.

1.5 Web Analytics

The analysis of online activity includes, but is not limited to, visits to websites and social media sites such as Facebook and LinkedIn.

Leading companies apply descriptive and advanced analytics to data collected in online experiments to determine the best way to

- configure websites,
- position ads, and
- utilize social networks to promote products and services.

Because of the massive pool of Internet users, experiments can be conducted without risking disrupting the company's overall business.

1.6 Ethical Issues in the Use of Data and Analytics

Increased attention has been paid to ethical concerns around data privacy and the ethical use of models based on data.

- Clients and customers must understand the trade-offs between allowing their data to be collected and the benefits they accrue from allowing a company to collect and use that data.
- An agreement must be signed between the customer and the company.

Companies have an obligation to uphold that agreement and make every effort to ensure that the data are protected from data breaches.

- Data breaches, defined as unauthorized uses of data, are a major concern for all companies.

1.6 Legal Issues in the Use of Data and Analytics

The General Data Protection Regulation (GDPR), one of the strictest privacy laws that went into effect in the European Union in May 2018, stipulates that

- the request for consent to use an individual's data must be easily understood and accessible,
- the intended use of data must be specified and easy to withdraw consent, and
- the individual has a right to a copy of their data and the right to demand their data be erased.

It is the responsibility of analytics professionals to understand the laws associated with collecting, storing, and using individuals' data.

1.6 INFORMS Ethics Guidelines Relative to Society

Analytics professionals should aspire to be

- accountable for their professional actions and the impact of their work,
- forthcoming about their assumptions, interests, sponsors, motivations, limitations, and potential conflicts of interest,
- honest in reporting their results, even when they fail to yield the desired outcome,
- objective in their assessments of facts, irrespective of their opinions or beliefs,
- respectful of the viewpoints and the values of others, and
- responsible for undertaking research and projects that provide positive benefits by
  - advancing our scientific understanding
  - contributing to organizational improvements, and
  - supporting social good.

1.6 INFORMS Ethics Guidelines Relative to Organizations

Analytics professionals should aspire to be

- accurate in our assertions, reports, and presentations,
- alert to possible unintended or negative consequences that our results and recommendations may have on others,
- informed of advances and developments in the fields relevant to our work,
- questioning whether there are more effective and efficient ways to reach a goal,
- realistic in our claims of achievable results and in acknowledging when the best course of action may be to terminate a project,
- rigorous by adhering to proper professional practices in the development and reporting of our work.

1.6 INFORMS Ethics Guidelines Relative to the Profession

Analytics professionals should aspire to be

- cooperative by sharing best practices, information, and ideas with colleagues, young professionals, and students,
- impartial in our praise or criticism of others and their accomplishments, setting aside personal interests,
- inclusive of all colleagues and rejecting discrimination and harassment in any form,
- tolerant of well-conducted research and well-reasoned results, which may differ from our own findings or opinions,
- truthful in providing attribution when our work draws from the ideas of others,
- vigilant by speaking out against actions that are damaging to the profession.

Summary

- This introductory chapter began with a discussion of decision-making.
  - Decisions may be strategic, tactical, or operational.
- Business analytics can help us make better-informed decisions.
- There are three categories of analytics:
  - descriptive, predictive, and prescriptive.
- Big data is data that is too large for typical desktop software to handle.
- Cloud computing has made storing and processing vast amounts of data more efficient and cost-effective.
- We also discussed various application areas of analytics.
- We concluded the chapter with a discussion of legal and ethical issues in the use of data and analytics.