CHAPTER 3

INTRODUCTION TO DATA ANALYTICS

Data is at the **core of modern decision-making** and business strategy. This chapter shows how businesses move from simply **describing past events** to **predicting future outcomes** and **prescribing optimal solutions** — through the **Data Analytics Cycle**, **Gartner's Data Analytics Model** and the four stages: **Descriptive, Diagnostic, Predictive, Prescriptive**.

CHAPTER ROADMAP

1 The data analytics cycle — 7 stages
2 Data analytics stages — 4 stages
3 Applications of data analytics — maturity model
4 Implications of data analytics — + / −

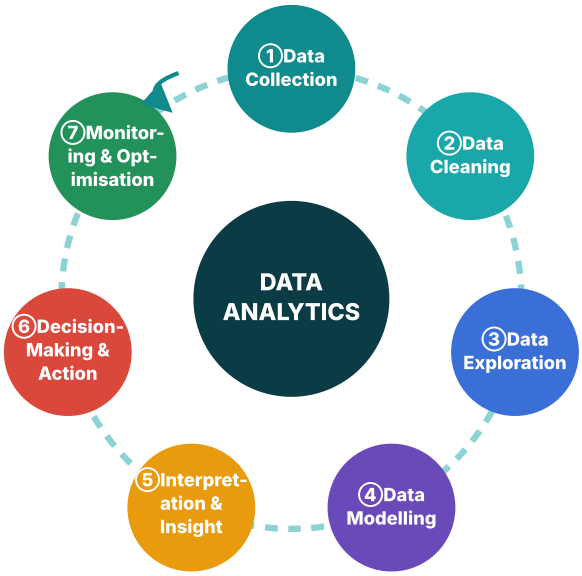
DEFINITION

Data analytics refers to the process of examining data sets to uncover trends, patterns and insights that can inform decision-making.

It involves various techniques — from **simple data summarisation** to **advanced machine learning models**.

1 THE DATA ANALYTICS CYCLE

systematic · iterative



Why it's a *cycle*

A **systematic approach** to transforming **raw data into actionable insights**. It is **iterative** — **each phase informs the next**, letting analysts continuously refine their understanding of the data and its implications.

LOOP Stage ⑦ **Monitoring & Optimisation** creates a **feedback loop** — the whole cycle is revisited to drive **ongoing improvement**. Insights in stage ⑤ may also raise new questions → another iteration.

Collect · Clean · Explore · Model · Interpret · Decide · Monitor

1 Data Collection

Gather data from **databases, surveys, sensors, web scraping**. Must be **relevant, accurate, comprehensive**; can be structured or unstructured.

2 Data Cleaning

a.k.a. **data cleansing / scrubbing**. Remove duplicates, fill missing values, **normalise formats**, correct entry errors.

3 Data Exploration

Summary statistics, visualisations, reports — **distributions, correlation matrices, scatter plots** → patterns, **outliers**, relationships.

4 Data Modelling

From descriptive statistics to **ML algorithms**: **regression, classification, clustering, time-series forecasting**.

5 Interpretation & Insight Generation

What do results mean **in context**? Translate raw numbers into **actionable business insights**.

6 Decision-Making & Action

Insights feed decisions — adjust **strategies**, refine **processes**, implement **new initiatives**.

7 Monitoring & Optimisation

Track outcomes; were decisions effective? Adjust & repeat analysis → **refine models**.

2 DATA ANALYTICS STAGES

descriptive → diagnostic → predictive → prescriptive

Understanding these four stages is crucial for **deriving actionable insights** and enhancing **organisational efficiency**.

Descriptive
What happened?

First stage. **Summarises historical data** to understand what has happened over a specific period.

Techniques: averages, percentages, visualisations (charts, graphs).

Sticky-note techniques
Data aggregation, visualisation, summarisation

Diagnostic
Why did it happen?

Builds on descriptive. Digs deeper to find **causes** of trends or anomalies.

Techniques: statistical techniques & **data mining** → relationships, correlations, **root causes**.

Sticky-note techniques
Drill-down analysis, correlation analysis, anomaly detection

Predictive
What will happen?

Uses **historical data to forecast** future outcomes → **proactive** decisions.

Relies on: machine learning models, statistical algorithms, data mining.

Sticky-note techniques
Regression, time series analysis, classification, clustering

Prescriptive
How can I make it happen?

Goes beyond prediction — **recommends actions** to optimise outcomes; suggests the **best course of action**.

Involves: optimisation techniques & **decision-support tools**.

Sticky-note techniques
Optimisation algorithms, simulations, decision trees

EXAMPLE · DESCRIPTIVE IN RETAIL
Aggregate last quarter's sales → **top-selling products**, **highest-sales regions**, **peak customer activity** periods. Explains the past; a **foundation** for future decisions.

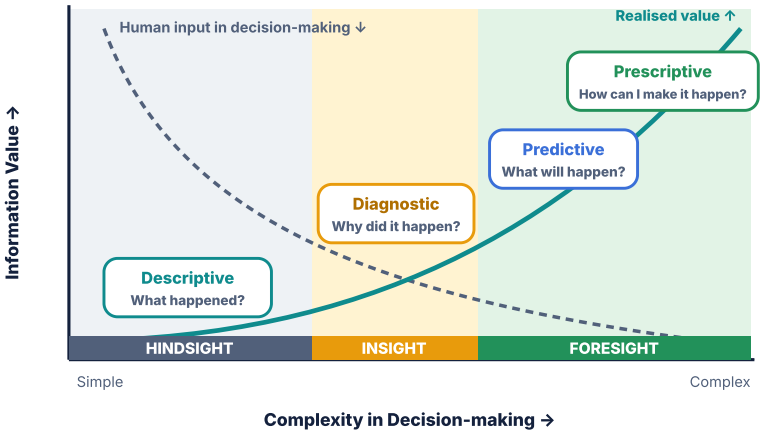
CASE · DIAGNOSTIC IN HEALTHCARE
Readmissions rising for 6 months → investigate conditions, treatments, demographics → **root cause**: insufficient follow-up care for chronic patients → changes reduce readmissions.

EXAMPLE · PREDICTIVE IN FINANCE
Forecast **loan default rates** from credit scores, employment history, repayment behaviour → identify **high-risk borrowers** → adjust loan terms / financial counselling.

CASE · PRESCRIPTIVE IN MANUFACTURING
Fluctuating demand → historical demand data + **optimisation algorithms** → **ideal production levels**, no overproduction / excess inventory; may also recommend **procurement** changes.

3 APPLICATIONS · DATA ANALYTICS MATURITY MODEL

hindsight → insight → foresight



Read the model

As we move from **hindsight (Descriptive)** to **foresight (Prescriptive)**:

- **↓ Human input** in decision-making decreases
- **↑ Complexity** of decisions increases
- **↑ Value** of information derived increases

Hindsight = Descriptive · Insight = Diagnostic · Foresight = Predictive & Prescriptive *(per figure)*

3 APPLICATIONS OF DATA ANALYTICS (CONT.)

from customer experience to operations

Data analytics can be applied across industries — e.g., **retail** (forecasting sales trends), **healthcare** (predicting disease outbreaks), **finance** (optimising investment strategies), **manufacturing** (improving supply chain efficiency).

Stage	Finance — study-text example	Airline case study
Descriptive	Analysing transaction data to find patterns in **customer spending behaviour**	Review past flight data — passenger numbers, on-time performance, complaints → routes with frequent delays
Diagnostic	Why certain **investment portfolios** performed better, by analysing market data	When delays occur, analyse **weather, air traffic, maintenance records** to pinpoint causes
Predictive	Predicting **stock price movements** using historical data & ML models	Forecast **future demand** → adjust ticket prices, schedules, staffing for peak periods
Prescriptive	**Recommending investment strategies** to optimise returns based on predicted conditions	Decide **schedules, crew assignments, personalised marketing** → cost savings, better experience

4 IMPLICATIONS OF DATA ANALYTICS

positive & challenging

Improved Decision-Making
Decisions based on **facts rather than intuition** → more accurate & timely → better outcomes.

Increased Efficiency
Identify **inefficiencies** → streamlined processes & **cost savings**.

Competitive Advantage
Respond faster to market changes, optimise operations, understand **customer needs**.

Challenge: Data Quality
Needs **high-quality data**; poor data → inaccurate predictions, misguided decisions.

KEY POINT Ensuring data **accuracy, completeness and consistency** is a **major challenge** — analytics is only as reliable as the data behind it (recall the **Data Cleaning** stage of the cycle).

Iterative Nature (Sticky Notes)

Analyse (describe · diagnose · predict · prescribe) › **Act** (decisions & initiatives) › **Monitor** (track outcomes) › **Refine & Optimise** (adapt to changing conditions)

Data analytics is **not a one-time process** but a **continuous cycle** of refinement, monitoring and optimisation.

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1 Count the cycle
The data analytics cycle has **7 stages**; the analytics **stages** are **4**. Don't mix them.

2 Cleaning ≠ Exploration
Cleaning = fix duplicates, missing values, formats. Exploration = summary stats, plots, find **outliers**.

3 Match the question
What happened = Descriptive · Why = Diagnostic · What will = Predictive · How to make it happen = Prescriptive.

4 Technique giveaways
Drill-down / correlation / anomaly detection = **Diagnostic**. Regression / time series / clustering = **Predictive**. Optimisation / simulation / decision trees = **Prescriptive**.

5 Direction of the model
Hindsight → foresight: **human input falls**; complexity & value **rise**.

6 Predictive vs Prescriptive
Predictive **forecasts**; prescriptive **recommends the best action** based on predictions.

CLASSIFY IT · STAGE

1	Top-selling products last quarter	Descriptive
2	Root cause of rising readmissions	Diagnostic
3	Forecasting loan default rates	Predictive
4	Ideal production levels via optimisation	Prescriptive
5	Customer spending patterns from transactions	Descriptive
6	Why one portfolio outperformed	Diagnostic
7	Airline forecasts peak demand	Predictive
8	Airline decides crew assignments	Prescriptive

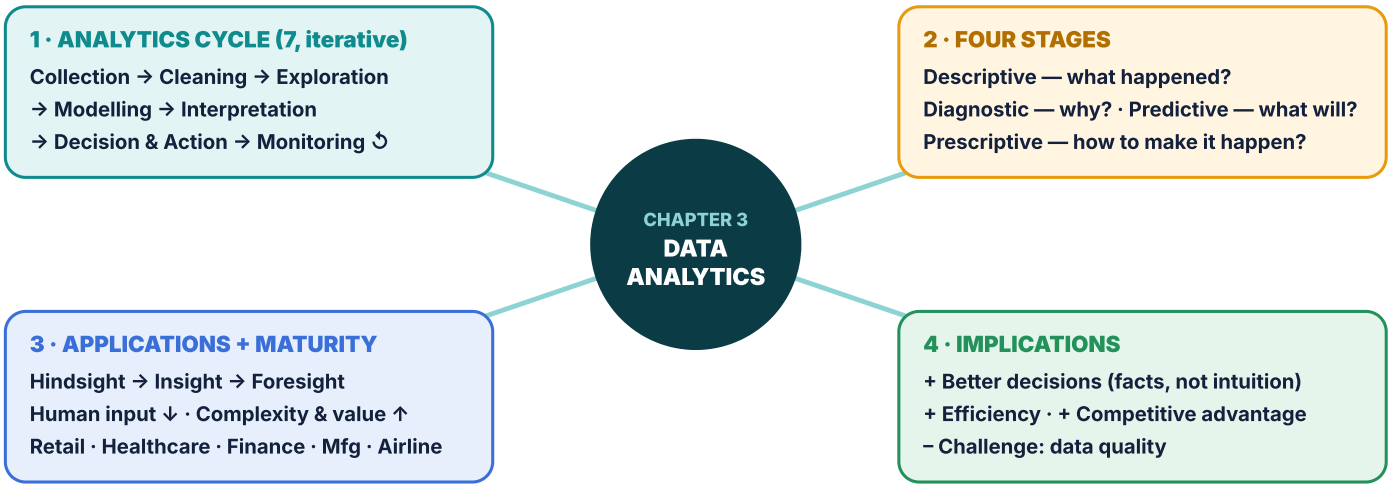
CLASSIFY IT · CYCLE

1	Web scraping product data	① Collection
2	Removing duplicate rows	② Cleaning
3	Scatter plot to spot outliers	③ Exploration
4	Building a regression model	④ Modelling
5	Translating results into business meaning	⑤ Interpretation
6	Changing strategy based on insight	⑥ Decision
7	Tracking whether decision worked	⑦ Monitoring

One question per stage

Descriptive	What happened?
Diagnostic	Why did it happen?
Predictive	What will happen?
Prescriptive	How can I make it happen?

REVISION MAP



Descriptive
Summarise the past: aggregation, visualisation, summarisation.

Diagnostic
Find root causes: drill-down, correlation, anomaly detection.

Predictive
Forecast: regression, time series, classification, clustering.

Prescriptive
Recommend best action: optimisation, simulation, decision trees.