



Data Analytics Using Python

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Introduction

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Contents

- 1 Introduction to Data Analytics
- 2 Data Analytics Process
- 3 Scope of Data Analytics
- 4 Data in Decision-Making
- 5 Types of Data Analytics
- 6 Business Analytics
- 7 Business Value
- 8 Comparative Case Study
- 9 Data to Business Value
- 10 Challenges and Limitations
- 11 Tutorial Activities

Introduction to Data Analytics

In today's digital world, organizations generate huge amounts of data from many different sources.

- Websites and mobile applications
- Social media
- Business transactions
- Sensors and IoT devices
- Healthcare systems
- Educational institutions
- Banking systems

However, raw data alone does not provide useful decisions.

Key Idea

Data must be collected, processed, analyzed, and interpreted to obtain meaningful information and insights.

What is Data Analytics?

Definition

Data Analytics is the systematic process of collecting, cleaning, transforming, analyzing, and interpreting data to discover useful patterns, trends, relationships, and insights that support decision-making.

In simple words:

Data Analytics converts raw data into useful information and actionable insights.

Raw Data → Analysis → Insight → Decision

Example: E-Commerce Sales

Suppose an e-commerce company has the following monthly sales:

Month	Sales
January	Rs. 5,00,000
February	Rs. 5,50,000
March	Rs. 5,20,000
April	Rs. 4,80,000
May	Rs. 4,50,000

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After analyzing the values, the company may discover:

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Sales have decreased continuously after February.

Insight

The company can investigate the reason for the decrease and decide whether to introduce discounts, improve marketing, or change its product strategy.

Data Analytics Process

A typical data analytics process consists of:

Collect → Clean → Process → Analyze → Visualize → Interpret → Decide

- ① Data Collection
- ② Data Cleaning
- ③ Data Processing
- ④ Data Analysis
- ⑤ Data Visualization
- ⑥ Interpretation
- ⑦ Decision-Making

1. Data Collection

Data is collected from different sources.

- Databases
- Websites
- Surveys
- Sensors
- Transaction systems
- Social media
- Mobile applications
- Healthcare systems
- Educational systems
- Banking systems

Example

An e-commerce company can collect customer purchases, browsing history, ratings, prices, and transaction information.

2. Data Cleaning

Real-world data is often imperfect.

Common problems include:

- Missing values
- Duplicate records
- Incorrect values
- Inconsistent formats
- Outliers

Why is Cleaning Important?

Poor-quality input data can lead to incorrect analysis and poor decisions.

3. Data Processing

Data processing transforms data into a suitable form for analysis.

Common operations include:

- Sorting
- Filtering
- Aggregation
- Transformation
- Encoding
- Normalization

Raw Data → Processed Data

4. Data Analysis

Data analysis attempts to identify meaningful patterns.

It can reveal:

- Patterns
- Trends
- Relationships
- Correlations
- Anomalies
- Customer behavior
- Performance changes
- Risk factors

5. Data Visualization

Analytical results can be communicated using:

- Tables
- Bar charts
- Line graphs
- Pie charts
- Dashboards
- Reports
- Heatmaps
- Interactive visualizations

Purpose

Visualization makes analytical results easier to understand and communicate.

Scope of Data Analytics

Data analytics is used across almost every industry.

- Business
- Healthcare
- Education
- Banking
- Finance
- E-Commerce
- Manufacturing
- Transportation
- Telecommunications
- Government

Applications of Data Analytics

Domain	Example Application
Business	Sales and customer analysis
Healthcare	Disease prediction and patient monitoring
Education	Student performance analysis
Banking	Fraud detection and credit scoring
E-Commerce	Recommendation and demand forecasting
Manufacturing	Predictive maintenance and quality control
Transportation	Route and traffic analysis

Importance of Data in Decision-Making

Traditionally, many decisions were based on:

- Experience
- Intuition
- Assumptions
- Personal judgment

Modern organizations increasingly use:

Data-Driven Decision-Making

Data → Analysis → Evidence → Decision

Why is Data Important?

- Better accuracy
- Identify trends
- Understand customers
- Reduce risk
- Improve efficiency
- Reduce costs
- Improve customer satisfaction
- Gain competitive advantage

Example

A company can analyze historical demand to decide how much inventory should be maintained.

Four Types of Data Analytics

Type	Main Question
Descriptive	What happened?
Diagnostic	Why did it happen?
Predictive	What is likely to happen?
Prescriptive	What should we do?

What happened → Why → What will happen → What should we do?

Descriptive Analytics

Definition

Descriptive analytics analyzes historical data to understand and summarize what has already happened.

Question: What happened?

Common techniques:

- Totals
- Averages
- Percentages
- Counts
- Minimum and maximum
- Reports and dashboards
- Charts

Descriptive Analytics: Example

A company reports:

Year	Sales
2023	Rs. 10 crore
2024	Rs. 12 crore
2025	Rs. 15 crore

Interpretation

The report summarizes historical sales.

Descriptive Analytics $\Rightarrow$ What happened?

Diagnostic Analytics

Definition

Diagnostic analytics investigates data to determine the causes or reasons behind an event.

Question: Why did it happen?

Common techniques:

- Drill-down analysis
- Correlation analysis
- Comparison
- Root-cause analysis
- Filtering
- Segmentation

Diagnostic Analytics: Example

Suppose:

Sales decreased by 20%.

Possible causes:

- Product price increased
- Competitors introduced discounts
- Advertising decreased
- Product quality declined
- Customer complaints increased

Key Question

Why did sales decrease?

Predictive Analytics

Definition

Predictive analytics uses historical data, statistical methods, and machine-learning techniques to estimate future outcomes.

Question: What is likely to happen?

Techniques include:

- Regression
- Classification
- Decision Trees
- Random Forests
- Neural Networks
- Time-Series Forecasting

Predictive Analytics: Examples

- A bank predicts which customers are likely to default.
- A university predicts students at risk of failing.
- An e-commerce company predicts next month's demand.
- A hospital predicts the probability of patient readmission.

Important

Predictive analytics estimates the likelihood of future outcomes. It does not guarantee the future.

Prescriptive Analytics

Definition

Prescriptive analytics recommends possible actions based on data, predictions, objectives, and constraints.

Question: What should we do?

Applications include:

- Optimal pricing
- Inventory optimization
- Route optimization
- Resource allocation
- Production planning
- Marketing strategies

Prescriptive Analytics: Example

Suppose predictive analytics determines:

Demand is expected to increase by 30%.

Prescriptive analytics may recommend:

Increase inventory and production.

Prediction → Recommended Action

Comparison of Four Types

Type	Question	Focus	Example
Descriptive	What happened?	Past	Sales decreased by 15%.
Diagnostic	Why did it happen?	Past	Competitor discounts caused the decrease.
Predictive	What will happen?	Future	Sales may decrease further.
Prescriptive	What should we do?	Action	Introduce targeted discounts.

Complete Example: E-Commerce

Consider an online shopping company.

- ① **Descriptive:** Sales decreased by 15% in July.
- ② **Diagnostic:** Website traffic decreased and competitors offered larger discounts.
- ③ **Predictive:** Sales may decrease by another 10% next month.
- ④ **Prescriptive:** Increase digital advertising and provide targeted discounts.

Analytics Chain

What happened → Why → What next → What action?

Business Analytics

Definition

Business Analytics is the use of data, statistical techniques, analytical methods, and computational tools to support business decision-making and improve organizational performance.

Business Analytics = Data Analytics Applied to Business Problems

- Marketing
- Sales
- Finance
- Human Resources
- Supply Chain
- Customer Service
- Operations

Data Analytics vs Business Analytics

Data Analytics

Broad concept

Used in many domains

Finds patterns and insights

Applied to healthcare, education, science, etc.

Technical and analytical focus

Business Analytics

Business-focused application

Primarily focused on organizations

Uses insights to improve business decisions

Mainly applied to business functions

Decision and business-value focus

Business Value of Analytics

Definition

Business value is the measurable benefit obtained by using data and analytics to improve organizational performance and decision-making.

Major forms of business value:

- Increased revenue
- Reduced costs
- Better customer experience
- Better decisions
- Risk reduction
- Improved efficiency
- Better resource utilization
- Competitive advantage

How Analytics Creates Business Value

Increased Revenue

- Identify high-value customers.
- Identify profitable products.
- Discover new market opportunities.

Reduced Costs

- Identify unnecessary expenses.
- Reduce inefficient processes.
- Optimize inventory.

Improved Customer Experience

- Understand customer preferences.
- Personalize recommendations.
- Improve service quality.

Comparative Case Study: Retail

Consider two retail stores.

Store A – Traditional Retailer

- Manager experience
- Customer observations
- Historical assumptions

Store B – Data-Driven Retailer

- Historical sales
- Customer purchases
- Weather information
- Customer demographics
- Product ratings
- Inventory data
- Seasonal trends

Traditional vs Data-Driven Retail

Factor	Store A	Store B
Decision basis	Experience	Data + Analysis
Customer understanding	Limited	Detailed
Demand forecasting	Limited	Predictive
Inventory management	Manual	Data-driven
Personalization	Low	High
Risk	Relatively high	Reduced
Decision speed	Moderate/slow	Faster
Business value	Limited	Higher potential

Applying Four Analytics to Retail

Suppose Store B wants to analyze umbrella sales.

- **Descriptive:** How many umbrellas were sold last year?
- **Diagnostic:** Why were umbrella sales higher in July?
- **Predictive:** How many umbrellas are likely to be sold next July?
- **Prescriptive:** How many umbrellas should the store order for next July?

Past → Cause → Future → Action

Case Study: University Student Performance

Suppose a university collects:

- Attendance
- Internal marks
- Assignment marks
- Previous semester performance
- Quiz scores
- Final examination marks

Descriptive: Average marks of students.

Diagnostic: Why are students performing poorly?

Predictive: Which students are likely to fail?

Prescriptive: Recommend tutorials, mentoring, or remedial classes.

Case Study: Banking

A bank has customer transaction data.

- **Descriptive:** How many transactions occurred this month?
- **Diagnostic:** Why did fraudulent transactions increase?
- **Predictive:** Which transactions are likely to be fraudulent?
- **Prescriptive:** Should the transaction be blocked or verified?

Business Value

Fraud detection can reduce financial losses and improve customer security.

Case Study: Food Delivery

A food-delivery company has data about:

- Orders
- Delivery times
- Customer ratings
- Restaurants
- Locations
- Discounts
- Delivery partners

Descriptive: What was the average delivery time last month?

Diagnostic: Why did delivery time increase on weekends?

Predictive: Which locations are likely to have high demand?

Prescriptive: How many delivery partners should be allocated?

From Data to Business Value

Data → Processing → Analytics → Insight → Decision → Action → Business Value

Example

Customer purchase data



Analyze purchase patterns



Identify frequently purchased products



Predict customer preferences



Recommend products



Data, Information, Insight, Decision and Action

Data	Raw facts and observations.
Information	Processed data that has meaning.
Insight	Meaningful conclusion obtained through analysis.
Decision	Choice made using information and insights.
Action	Implementation of the decision.

Example

Data: 85, 76, 92, 65

Information: Average mark = 79.5

Insight: Low attendance is associated with lower marks.

Decision: Provide additional support.

Action: Conduct additional tutorial classes.

Challenges and Limitations

- Poor data quality
- Privacy concerns
- Data security
- Bias
- Lack of skills
- Cost
- Complex infrastructure
- Misinterpretation

Important

Good analytics requires good-quality data, appropriate methods, proper interpretation, and responsible use of information.

Tutorial Activity: Identify the Analytics Type

Identify whether each situation is Descriptive, Diagnostic, Predictive, or Prescriptive.

- ① A company reports total sales for each month.
- ② A company investigates why sales decreased.
- ③ A bank predicts loan default.
- ④ An e-commerce system recommends products.
- ⑤ A university reports average marks.
- ⑥ A hospital predicts patient readmission.
- ⑦ A company determines the optimal product price.

Group Activity: Data to Decision

Divide students into groups.

Group	Industry
Group 1	E-Commerce
Group 2	Banking
Group 3	Healthcare
Group 4	Education
Group 5	Food Delivery

Each group should identify:

Problem → Data → Analytics → Decision → Business Value

Case-Based Question

Problem

A company observes that its monthly sales have decreased by 20%. It has customer, sales, product, pricing, and competitor data.

Explain how:

- ① Descriptive analytics can be used.
- ② Diagnostic analytics can be used.
- ③ Predictive analytics can be used.
- ④ Prescriptive analytics can be used.

Thank You

Questions?