1.2 — Types of Data Analytics

Overview

Syllabus point 1.2 focuses on the various types of data analytics, which are fundamental for anyone entering the analytics field. Understanding these types is crucial for effectively analyzing data and deriving actionable insights. The main types covered are:

1. Descriptive Analytics
2. Diagnostic Analytics
3. Predictive Analytics
4. Prescriptive Analytics
5. Visual Analytics

This section will break down and elaborate on each type, providing definitions, origins, case scenarios, real-world connections, and supplementary visuals.

1. Descriptive Analytics

Definition

Descriptive analytics is the process of summarizing historical data to answer the question: *What has happened?* It transforms raw data into stable, understandable information through aggregation, reporting, and data visualization.

Origin & Research

- **Historical Roots**: The concept of descriptive statistics can be traced back to early statistical work, such as John Graunt's *Bills of Mortality* in the 17th century, which analyzed death records to understand population health.
- **Business Intelligence**: The importance of descriptive analytics in business is highlighted in Davenport and Harris's *Competing on Analytics* (HBR, 2007), which emphasizes its role in decision-making.

Methods & Concepts

- **Statistical Measures**: Common measures include mean, median, mode, and standard deviation, which help summarize data.
- **Visualization Techniques**: Tools such as bar charts, pie charts, and dashboards are used to present data visually, making it easier to interpret.

Real-Life Example

- **Swiggy**: Analyzes the number of biryanis sold last month to understand customer preferences.
- **YouTube**: Tracks view counts for each creator per month to assess content performance.

Business Application

- Retailers analyze monthly sales trends to adjust inventory and marketing strategies.
- Hospitals track the number of patient admissions weekly to manage staffing and resources effectively.

Case Scenario

A retail store summarizes its sales records month-wise. Managers notice a spike in December sales and investigate further to understand the cause, leading to targeted marketing strategies for the holiday season.

2. Diagnostic Analytics

Definition

Diagnostic analytics seeks to explain *why something happened*. It analyzes data to examine causes and relationships, employing techniques such as root cause analysis, data mining, and drill-down.

Origin & Research

- **Historical Roots**: The concept originated from root cause analysis and Six Sigma methodologies, which focus on identifying the underlying causes of problems.
- **Philosophical Basis**: Diagnostic analytics is rooted in the philosophy of scientific explanation, particularly Aristotle's concept of causality, which seeks to understand the reasons behind events.

Methods & Concepts

- **Analytical Techniques**: Common methods include correlation and regression analysis, drill-down, data mining, hypothesis testing, and Pareto analysis, which helps prioritize issues based on their impact.

Real-Life Example

- **YouTube**: Diagnoses why user engagement dropped after a certain point in a video, allowing creators to adjust content accordingly.
- **Healthcare**: A hospital investigates why flu admissions doubled last week, leading to proactive measures in patient care.

Business Application

- E-commerce platforms analyze why customer churn increased, allowing them to implement retention strategies.
- IT departments investigate why a website crashed during high traffic, leading to infrastructure improvements.

Case Scenario

A telecom company notes an increase in dropped calls. Diagnostic analytics reveals that network congestion in a specific city area is due to a local festival, prompting the company to allocate additional resources to that area.

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3. Predictive Analytics

Definition

Predictive analytics uses historical data and statistical models to forecast *what is likely to happen*. It identifies patterns to predict future outcomes, enabling organizations to make informed decisions.

Origin & Research

- **Historical Roots**: Predictive analytics has roots in actuarial science and credit scoring, with significant contributions from Ronald Fisher's work on logistic regression in 1936.
- **Modern Applications**: It is heavily utilized in machine learning and time-series forecasting, allowing for more sophisticated predictions.

Methods & Concepts

- **Analytical Techniques**: Common methods include regression models, classification algorithms, machine learning techniques, neural networks, decision trees, and time-series analysis (e.g., ARIMA models).

Real-Life Example

- **Amazon**: Predicts which products you are likely to buy next based on your browsing and purchase history, enhancing the shopping experience.
- **Banks**: Use predictive analytics for assessing credit risk, helping them make informed lending decisions.

Business Application

- Insurance companies predict the probability of claims based on historical data, allowing for better risk management.

- Marketing teams forecast the success of campaigns based on past performance, optimizing resource allocation.

Case Scenario

An airline predicts how many seats will be unsold for a specific route and dynamically adjusts ticket prices to optimize revenue, ensuring maximum occupancy and profitability.

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4. Prescriptive Analytics

Definition

Prescriptive analytics recommends *what action to take*. It goes beyond prediction to suggest decisions and actions after weighing possible outcomes, helping organizations optimize their strategies.

Origin & Research

- **Historical Roots**: Prescriptive analytics evolved from operations research and optimization, with significant contributions from Richard Bellman in the 1950s on dynamic programming.

- **Decision Theory**: It ties closely to decision theory and reinforcement learning, which focus on making optimal decisions based on available data.

Methods & Concepts

- **Analytical Techniques**: Common methods include simulation, recommendation engines, optimization models, decision analysis, and what-if scenarios that explore potential outcomes.

Real-Life Example

- **Swiggy**: Suggests optimal delivery routes for drivers based on real-time traffic data, improving delivery efficiency.
- **Uber**: Calculates driver incentives and surge pricing based on demand patterns, ensuring a balance between supply and demand.

Business Application

- Supply chain management provides the best inventory order quantities, reducing costs and improving service levels.
- Healthcare systems suggest optimal treatment pathways based on patient data, enhancing patient outcomes.

Case Scenario

A logistics provider uses prescriptive analytics to recommend the fastest delivery path, considering traffic, weather, and order priority, leading to improved customer satisfaction and reduced delivery times.

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5. Visual Analytics

Definition

Visual analytics combines automated data analysis with interactive visual representations, enabling users to intuitively understand large datasets and make insightful decisions.

Origin & Research

- **Historical Roots**: The term was coined in the 2000s, notably in Thomas and Cook's *Illuminating the Path: The Research and Development Agenda for Visual Analytics* (2005).
- **Integration of Fields**: It merges data visualization (Tufte, Cleveland) with analytical computation, enhancing the ability to interpret complex data.

Methods & Concepts

- **Visualization Techniques**: Common methods include dashboards, heatmaps, mapping, interactive filtering, and user-driven exploration combined with analytical models.

Real-Life Example

- **YouTube Studio**: Provides an interactive dashboard with metrics, channel growth, and audience demographics, allowing creators to track performance.
- **COVID Dashboards**: Track real-time cases, trends, and projections, helping public health officials make informed decisions.

Business Application

- Retailers use sales heatmaps to identify store performance, allowing for targeted marketing efforts.
- Health agencies monitor outbreak hotspots on maps, facilitating resource allocation and response planning.

Case Scenario

A pharmaceutical company uses an interactive dashboard that allows executives to visually explore global drug sales, filter by region, and correlate with marketing spend, leading to data-driven strategic decisions.

Visuals

Descriptive Analytics

- **Bar Chart**: Showing sales by month, illustrating trends over time.

Diagnostic Analytics

- **Scatter Plot**: With a regression line, showing the relationship between ad spend and sales, helping identify effective marketing strategies.

Predictive Analytics

- **Time-Series Line Graph**: Forecasting future website traffic, enabling proactive resource management.

Quick Reference Table

Type	Definition	Key Methods/Concepts	Real-Life Example	Typical Origin/Research
Descriptive	What happened?	Summarization, dashboards, stats	Monthly sales trends, YouTube views	Descriptive stats (Graunt, 1662)
Diagnostic	Why did it happen?	Correlation, regression, root cause	YouTube engagement drop analysis	Root cause, Six Sigma
Predictive	What will happen?	ML, regression, time-series	Amazon product recommendation	Actuarial/statistics, ML
Prescriptive	What should we do?	Optimization, simulation, recommendation	Swiggy route suggestions	Operations research, decision theory
Visual	How best to show findings?	Dashboards, visual tools	COVID dashboards, KPIs	Visual analytics (Thomas & Cook)

References to Key Research, Concepts, and Origins

- John Graunt, *Natural and Political Observations Made upon the Bills of Mortality* (1662): First modern application of descriptive statistics.
- Ronald Fisher, *The Use of Multiple Measurements in Taxonomic Problems* (1936): Foundation for predictive statistical modeling.

- T.W. Anderson, *An Introduction to Multivariate Statistical Analysis* (1958): Diagnostic approaches in statistics.
- Richard Bellman, *Dynamic Programming* (1957): Optimization and prescriptive models.
- Thomas & Cook, *Illuminating the Path: The Research and Development Agenda for Visual Analytics* (2005): Foundation text for visual analytics.
- Davenport & Harris, *Competing on Analytics* (2007): Business analytics as a strategic tool.

Summary of Real-World Connections

- Businesses like Amazon, Swiggy, Uber, and YouTube rely on all layers of analytics to improve personalization, operational efficiency, and profitability.
- Government agencies and health organizations use prescriptive and visual analytics for resource planning and outbreak management.
- Everyday applications harness these analytical layers every time you see a recommendation, dashboard, or forecast.

Next Steps

Understanding these analytics types prepares you for deeper dives into tools like Excel, Python, and statistical software—where each type of analysis comes alive through case studies and hands-on practice.