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Computer Science Class 9 Notes

Chapter 9

Data Science and Data Gathering

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Chapter 9: Data Science and Data Gathering

Data consists of raw facts collected about things around us that we can process to generate useful information, taking many forms such as numbers, words, measurements, observations, images, and sounds. This chapter explores the two broad categories of data — qualitative (further split into nominal and ordinal) and quantitative (further split into discrete and continuous) — along with methods for organizing, collecting, storing, and visualizing data effectively.

The chapter also covers data pre-processing and analysis techniques (including statistical measures like mean, median, mode, range, variance, and standard deviation), collaborative tools and cloud storage, and closes with an introduction to data science, the data science workflow, Big Data and its 'Three Vs' (Volume, Velocity, Variety), practical applications across industries, and future trends in digital data management.

Learning Objectives

- Identify and differentiate between qualitative and quantitative data, including their sub-types
- Organize data effectively using tables, charts, and graphs
- Understand various data collection methods, including surveys, questionnaires, interviews, and observations
- Describe data storage techniques: spreadsheets, databases, data warehouses, and NoSQL
- Apply data visualization techniques to communicate information clearly
- Understand data pre-processing, including data validation, cleaning, and key statistical measures
- Understand the role of cloud storage and collaborative tools in data management
- Explain the fundamentals of data science, Big Data, and its real-world applications

Key Concepts

9.1 Data and Data Types

Data consists of raw facts collected about things around us that we can process to generate useful information — it can take many forms, including numbers, words, measurements, observations, images, and sounds, originating from sources like weather stations, sales records, surveys, websites, and social media. Understanding data is essential for comprehending situations, making informed decisions, solving problems, and driving innovation.

Data can be divided into two broad categories. Qualitative data refers to categories or labels that describe qualities or characteristics rather than quantities — it is non-numeric and categorical (e.g., student names, car colors, fruit types). Quantitative data consists of numbers used to measure the quantity or amount of something, answering questions like 'How much?' or 'How long?' — it is numerical, measurable, countable, and can be used in arithmetic operations.

9.2 Nominal, Ordinal, Discrete, and Continuous Data

Qualitative data is further classified into two types. Nominal Data is used to label or categorize items without implying any order (e.g., gender, types of fruit, colors) — it allows checking equality, grouping into categories, counting items, and finding the mode (most frequent category). Ordinal Data represents categories with a meaningful order, though the differences between categories are not uniform (e.g., satisfaction ratings, education levels, shirt sizes) — in addition to nominal operations, it allows comparisons, ranking, finding the median, and analyzing frequency distribution.

Quantitative data is further classified into two types. Discrete Data consists of distinct, separate, countable values, often whole numbers, answering questions like 'How many?' or 'How often?' (e.g., number of students in a class) — it supports arithmetic operations like addition and subtraction, and statistical operations like average and range. Continuous Data consists of values that can take any number within a given range, including fractions or decimals (e.g., student heights, fruit weights, temperatures) — in addition to discrete data

operations, it also supports division (e.g., dividing 2.5 kg of meat among ten people, yielding 0.25 kg each).

9.3 Organizing and Collecting Data

Organizing data systematically is important for clear analysis and reduces errors — well-organized data (in tables, charts, and graphs) saves time, improves clarity, and makes it easier to draw conclusions. Data Tables present information in rows and columns for easy comparison. Charts (bar charts, line charts, pie charts) are visual representations that help identify patterns, trends, and outliers. Graphs (line graphs, bar graphs, scatter plots, histograms) show relationships between data points.

Data collection is the process of gathering information to answer questions, make decisions, or understand something better. Key methods include: Surveys (collecting information by asking questions, on paper, phone, or online, e.g., via Google Forms); Questionnaires (written forms with a set of questions); Interviews (one-on-one conversations for detailed information); Observations (watching and noting behavior in a situation); and Online Data Sources (websites, databases, and digital tools). Good survey design should be clear, specific, short, use multiple-choice/rating scales, ensure anonymity, and be tested before distribution.

9.4 Structured vs. Unstructured Data and Storage Techniques

With respect to storage and processing, data has two types. Structured Data is organized and formatted to be easily searchable and analyzable, such as data in spreadsheets and traditional databases with rows (records) and columns (attributes). Unstructured Data is more free-form and doesn't fit into a specific format, such as text from emails, social media posts, videos, and images — it is harder to organize but can be very valuable.

Four important data storage technologies exist. Spreadsheets (e.g., Excel, Google Sheets) organize data in rows and columns for simpler tasks like budgeting. Databases are like digital filing cabinets storing structured data in tables, used in banking and school records. Data Warehouses are specialized databases for storing and analyzing large amounts of data from various sources to support business decisions (e.g., Amazon Redshift, Google BigQuery). NoSQL ('Not Only

SQL') databases flexibly store unstructured data using documents, key-value pairs, or graphs rather than tables (e.g., MongoDB, Cassandra), often used in big data and real-time applications.

9.5 Data Visualization

Data visualization is the process of turning numbers and information into pictures, making it easier to see patterns, trends, and relationships, and enabling quicker, better decisions. Popular visualization tools include Microsoft Excel, Google Sheets, Tableau (for detailed interactive visualizations), and Microsoft Power BI (for a wide variety of charts, graphs, and maps).

Different data types call for different visualization techniques: Nominal Data is best shown with bar charts or pie charts; Ordinal Data with bar charts or stacked bar charts; Discrete Data with histograms or dot plots; and Continuous Data with line graphs, scatter plots, or box plots. The human brain processes visuals roughly 60,000 times faster than text, which is why charts and graphs make complex information easier to understand quickly.

9.6 Data Pre-Processing and Analysis

Data pre-processing is the first and most important step in working with data, involving cleaning and organizing it before analysis — similar to washing and chopping ingredients before cooking. It involves evaluating data quality (checking for missing, incorrect, or inconsistent entries) and identifying errors (mistakes, like a score of 105 out of 100), outliers (unusual extreme values), and biases (distortions from an unrepresentative sample). Data Validation checks completeness and accuracy, while Data Cleaning removes errors, handles missing data (e.g., filling gaps with a class average), and addresses outliers.

Data analysis has two main types. Quantitative Analysis uses statistics: Measures of Centre include the Mean (sum of values divided by count), Median (the middle value when ordered), and Mode (the most frequent value); Measures of Spread include the Range (highest minus lowest value), Variance ($S^2 = \Sigma(x_i-\bar{x})^2/(n-1)$, how spread out values are from the mean), and Standard Deviation ($S = \sqrt{\text{Variance}}$, the average distance of data points from the mean). Qualitative Analysis deals with non-numeric data like text, using methods such as Content Analysis

(counting how often specific words/themes appear) and Thematic Analysis (identifying and interpreting broader themes and patterns).

9.7 Collaborative Tools and Cloud Storage

Cloud storage has become essential for how we store, access, and share information — saving files on the internet for access from any device, creating backups, and enabling real-time collaboration. Remote Access is the ability to connect to and use a computer or network from a distant location (e.g., editing a Google Drive file from home and later from school). Data Backups are copies of important data stored separately from the original to protect against loss from accidental deletion, hardware failure, or viruses.

Collaborative Authoring is the process of multiple people working together to create, edit, and improve a document or project in real-time using online tools (e.g., a group working together on Google Slides). Key benefits of collaborative tools include Enhanced Productivity (multiple people working on different sections simultaneously) and Version Control (automatically saving every change, so previous versions can be recovered and each person's edits are tracked).

9.8 Introduction to Data Science and Big Data

Data science is like being a detective, but instead of solving crimes, you solve problems using data — combining computer science (for handling and organizing data), mathematics and statistics (for analyzing data and finding patterns), and business knowledge (for applying insights to real-life decisions). The Data Science Workflow follows six steps: Problem Identification, Data Collection, Data Cleaning, Data Analysis, Data Interpretation, and Data Visualization.

Big Data refers to extremely large and complex data sets that are difficult to process using traditional methods, characterized by the 'Three Vs': Volume (the sheer amount of data collected), Velocity (the speed at which data is generated and processed), and Variety (the different forms data can take — text, images, videos, numbers). Big Data has practical applications in retail (product recommendations), healthcare (predicting disease outbreaks), finance (fraud detection), and transportation (route optimization). Key data science tools include Excel, Python (with Pandas and Matplotlib), R, and SQL, while important

techniques include Predictive Modelling (forecasting future events from historical data) and Graph Analytics (analyzing relationships between data points, e.g., social networks).

Important Definitions

What is data?

Raw facts collected about things around us that can be processed to generate useful information, taking forms such as numbers, words, measurements, images, or sounds.

What is qualitative data?

Data that refers to categories or labels describing qualities or characteristics rather than quantities, represented by words, labels, or symbols instead of numbers.

What is quantitative data?

Numerical data used to measure the quantity or amount of something, which is measurable, countable, and can be used in arithmetic operations.

What is structured data?

Data that is organized and formatted to be easily searchable and analyzable, such as data stored in spreadsheets and traditional databases with rows and columns.

What is data visualization?

The process of turning numbers and information into pictures, such as charts and graphs, to make patterns, trends, and relationships easier to understand.

What is data science?

An interdisciplinary field that combines computer science, mathematics/ statistics, and business knowledge to gather, analyze, and interpret data to solve problems and find useful insights.

What is Big Data?

Extremely large and complex data sets that are difficult to process using traditional methods, characterized by the Three Vs: Volume, Velocity, and Variety.

What is an outlier?

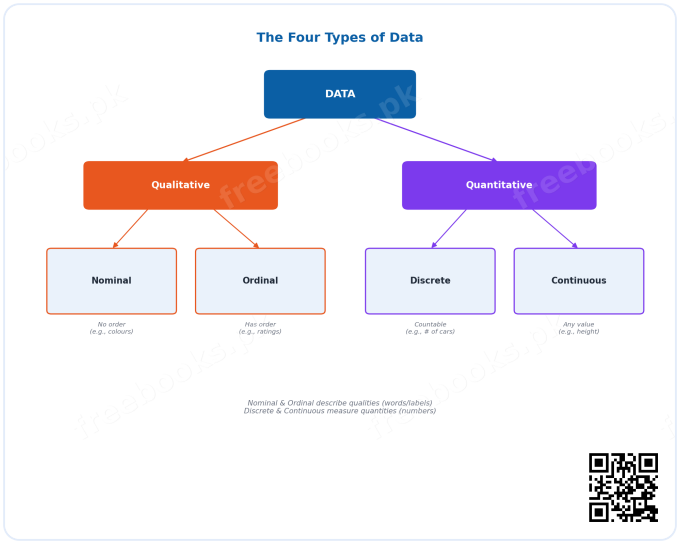
An unusual or extreme value in a dataset that doesn't fit the general pattern of the rest of the data.

Key Facts and Relations

Topic	Key Fact / Relation
2 broad data categories	Qualitative Data and Quantitative Data
4 data sub-types	Nominal, Ordinal (qualitative); Discrete, Continuous (quantitative)
4 data storage technologies	Spreadsheets, Databases, Data Warehouses, NoSQL
3 Vs of Big Data	Volume (amount), Velocity (speed), Variety (different forms)
3 measures of centre	Mean (average), Median (middle value), Mode (most frequent value)
Variance formula	$S^2 = \Sigma(x_i - \bar{x})^2 / (n - 1)$
Standard deviation formula	$S = \sqrt{\text{Variance}} = \sqrt{[\Sigma(x_i - \bar{x})^2 / (n - 1)]}$
6-step Data Science Workflow	Problem Identification → Data Collection → Data Cleaning → Data Analysis → Data Interpretation → Data Visualization

Diagrams

The Four Types of Data: A hierarchy diagram showing how Data splits into Qualitative (Nominal, Ordinal) and Quantitative (Discrete, Continuous) types, with examples

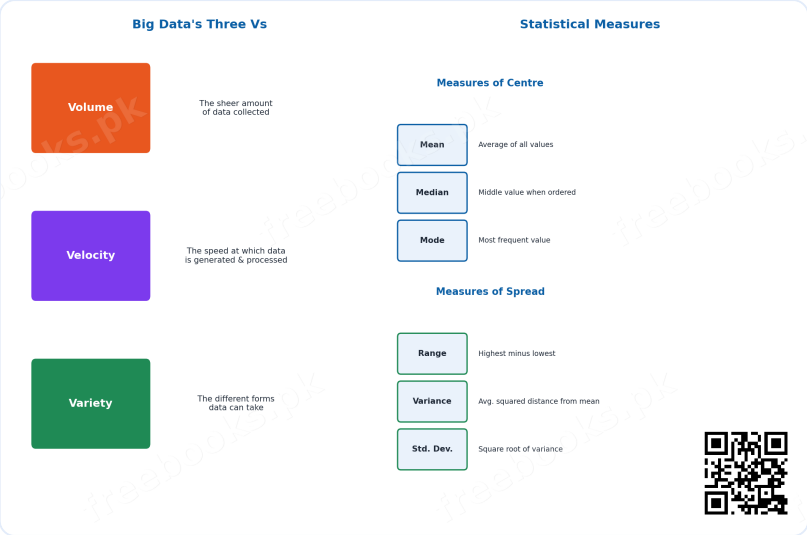


The Four Types of Data

The Data Science Workflow: A six-step flow diagram showing the data science process: Problem Identification, Data Collection, Data Cleaning, Data Analysis, Data Interpretation, and Data Visualization

The Data Science Workflow

Big Data's Three Vs and Statistical Measures: A diagram showing Big Data's Volume, Velocity, and Variety, alongside the key statistical measures of centre and spread used in quantitative analysis



Big Data's Three Vs and Statistical Measures

Short Questions & Answers

What is the difference between qualitative and quantitative data?

Qualitative data describes qualities or characteristics using categories or labels (non-numeric), while quantitative data consists of numbers that measure the quantity or amount of something and can be used in arithmetic operations.

Give an example of continuous data and explain why it is considered continuous.

Student height (e.g., 150.5 cm) is continuous data because it can take any value within a range, including fractions or decimals, rather than being limited to distinct, separate whole numbers.

Which method would you use to collect opinions from a large group of people about a new school policy?

A survey (potentially distributed online using a tool like Google Forms) would be an efficient method, as it allows many people to answer a standard set of questions quickly and the responses can be easily compiled and analyzed.

What type of data is the number of students in your class?

It is discrete quantitative data, since it consists of distinct, countable whole-number values (you cannot have a fractional number of students).

Why is it important to organize data into tables or charts before analyzing it?

Organizing data reduces errors, saves time when searching for information, and improves clarity, making it much easier to identify patterns, draw conclusions, and make decisions than working with a messy or unorganized list.

What is one advantage of using online tools like Google Forms for collecting survey data?

Online tools like Google Forms make it easy to distribute surveys widely, automatically compile responses, and quickly organize the collected data for analysis, saving significant time compared to paper-based surveys.

Explain why data visualization is important.

Data visualization turns complex numbers and information into pictures like charts and graphs, making it much easier and faster to see patterns, trends, and relationships, and supporting quicker, better-informed decisions.

What does the 'Variety' characteristic of Big Data refer to?

Variety refers to the different forms data can take, such as numbers, text, images, and videos — Big Data includes this wide range of data types and formats, not just numeric data.

Long Questions & Answers

Explain the differences between qualitative and quantitative data, and further differentiate between their respective sub-types, providing examples of each.

Data can broadly and fundamentally be divided into two genuinely distinct overarching categories, namely qualitative data and quantitative data, and properly and clearly understanding the specific underlying differences between these two particular broad categories, along with their own respective further sub-types, is an absolutely essential foundational skill within the wider field of data science as a whole. Qualitative data specifically refers to categories or descriptive labels that are used to describe the particular qualities or characteristics of something, rather than describing any kind of specific measurable quantity, and this particular type of data is generally represented using words, labels, or symbols rather than using numbers; qualitative data is itself further sub-divided into two more specific particular types, namely nominal data and ordinal data. Nominal data is specifically used to label or categorize

different items without implying any kind of meaningful order between those particular categories, such as, for example, categorizing people according to their gender, or categorizing various different pieces of fruit according to their particular type (apple, banana, orange); operations that can meaningfully be performed on nominal data specifically include checking for equality, grouping items together into categories, counting the number of items within each category, and identifying the single most frequently occurring category, which is more formally referred to as the mode. Ordinal data, by contrast, specifically represents various different categories that do have some kind of genuinely meaningful underlying order between them, even though the actual differences between those particular successive categories may not necessarily be perfectly uniform or equal in size, such as, for example, customer satisfaction ratings (satisfied, neutral, unsatisfied) or different shirt sizes (small, medium, large); in addition to all of the same operations that can already be performed on nominal data, ordinal data additionally also allows for meaningful comparisons and rankings to be made between categories, along with the calculation of a median value. Quantitative data, meanwhile, instead specifically consists of actual numbers that are used to properly measure the specific quantity or amount of something, and this particular type of data is itself further sub-divided into two more specific particular types, namely discrete data and continuous data. Discrete data specifically consists of distinct, individually separate values that are properly countable, generally expressed as whole numbers, such as, for example, the total number of students present within a given class; in addition to the same operations already available for both nominal and ordinal data, discrete data additionally also allows for various different arithmetic operations (such as addition and subtraction) and statistical operations (such as calculating an average or a range) to properly be performed on it. Continuous data, by contrast, instead specifically consists of values that are capable of taking on any particular number at all within some given specified range, including fractional or decimal values, such as, for example, a given student's height measured as 150.5 centimetres; in addition to all of the operations already available for discrete data, continuous data additionally also specifically allows for division to meaningfully be performed on it, such as, for example, being able to properly divide 2.5 kilograms of a given continuous substance like meat among ten

different individual people, in a way that would clearly not be possible with a genuinely discrete quantity such as three individual, indivisible cars.

Describe the complete Data Science Workflow, using a worked example to illustrate each of its six individual steps.

The Data Science Workflow refers to the complete systematic overall process that professional data scientists generally use in order to properly extract meaningful insights and useful knowledge from a given underlying set of raw data, and this particular systematic workflow consists of six individual sequential steps that build directly upon one another in turn. The first step is Problem Identification, which specifically involves properly understanding and clearly defining the precise underlying problem that one is actually attempting to solve; for example, imagine that a given school specifically wants to properly understand why a certain number of its students have been consistently arriving late to their classes. The second step is Data Collection, which specifically involves gathering the relevant necessary information from a range of various different appropriate sources; continuing with the same example, the school would specifically begin by collecting detailed data regarding the actual precise arrival times of its various different students. The third step is Data Cleaning, which specifically involves properly removing errors from the collected data and then subsequently organizing that data appropriately, in much the same general way that one might need to tidy up a messy room by putting every item back into its own correct designated place; in the given school example, this would specifically involve identifying and then properly fixing any obvious inconsistencies or errors that might exist within the originally collected arrival-time data. The fourth step is Data Analysis, which specifically involves closely and carefully examining the now properly cleaned data in order to identify any meaningful underlying patterns; in the given school example, this would specifically involve analysing the data in order to determine whether specific likely factors, such as adverse weather conditions or heavy traffic congestion, might actually be the underlying primary cause of these particular late arrivals. The fifth step is Data Interpretation, which specifically involves properly understanding what the various analysed patterns actually mean in a genuinely meaningful practical sense, and then subsequently drawing appropriate conclusions from them; in the given school example, this would specifically

involve the school properly concluding that heavy traffic congestion during a certain particular time of day does indeed appear to be the primary underlying cause of a majority of these late arrivals. The sixth and final step is Data Visualization, which specifically involves creating clear, easily understandable charts or graphs in order to properly communicate these particular findings to other people; in the given school example, this would specifically involve the school creating a simple, clear chart that visually displays the various different most common specific reasons for these particular late arrivals, thereby making the school's overall findings considerably easier for teachers, parents, and school administrators alike to properly and quickly understand at a single glance.

Explain the concept of Big Data, its defining characteristics (the Three Vs), and discuss its practical applications across at least three different industries.

Big Data specifically refers to extremely large and highly complex individual sets of data that have generally become simply too difficult to properly process using more traditional, older data-processing methods and tools, largely because of both the sheer overall scale and also the inherent underlying complexity of this particular kind of data. In order to properly understand and correctly characterize Big Data in a more precise, structured way, data scientists generally rely on three particular defining characteristics, commonly and collectively referred to as the 'Three Vs.' The first of these three defining characteristics is Volume, which specifically refers to the sheer overall total amount of data that is actually being collected at any given time, a clear, concrete example of this being the truly enormous number of individual posts, likes, and comments that are collectively shared across various different social media platforms on a single given day. The second defining characteristic is Velocity, which specifically refers to the actual particular speed at which new data is being both generated and then subsequently processed, a clear, concrete example of this being the way that new individual social media posts are continuously and very rapidly being sent out and received essentially in real time, in a way that has often been usefully compared to the fast, continuous flow of traffic along an extremely busy given highway. The third defining characteristic is Variety, which specifically refers to the many genuinely different particular forms that a given underlying set of data can actually take, since Big Data is very often not limited to simple numeric

values alone, but can instead also include various different forms of text, images, and video content as well, a clear, concrete example of this being a given company that separately collects customer reviews as raw text, various product photographs as images, and its own overall sales figures as simple numeric values. Big Data technology and its associated underlying analytical techniques have since found genuinely widespread practical application across a great many different specific industries. Within the retail industry specifically, given individual stores are able to properly analyse large amounts of collected customer data in order to correctly determine precisely which particular products tend to be the most popular at different specific particular times of the year, which then in turn helps those particular stores to stock the correct specific items and ultimately improve their own overall sales performance. Within the healthcare industry specifically, hospitals and individual doctors are similarly able to properly analyse large amounts of collected patient data in order to help anticipate seasonal disease outbreaks, such as an annual seasonal flu outbreak, well enough in advance to be able to properly prepare adequate vaccine supplies ahead of time. Within the finance industry specifically, banks are similarly able to properly analyse large amounts of collected customer transaction data in order to help correctly detect various different unusual or suspicious specific spending patterns that might potentially indicate an occurrence of fraud, thereby helping those particular banks to act quickly enough to properly protect their own individual customers' money from being stolen. Taken together as a whole, these various different real-world practical examples clearly and effectively illustrate precisely how Big Data technology, when properly combined together with modern advanced analytical techniques, is genuinely able to help many different kinds of organizations to make considerably better, more genuinely well-informed decisions across a great many different specific fields and specific industries.

Multiple Choice Questions (MCQs)

What is data? (A) Processed information (B) Raw facts gathered about things (C) A collection of numbers only (D) A list of observed events

Correct answer: (B) Raw facts gathered about things. Data refers to raw facts gathered about things around us, which can then be processed to generate useful information.

Which of the following is an example of qualitative data? (A) Temperature readings in degrees Celsius (B) Number of students in a class (C) Favourite ice cream flavours (D) Test scores out of 100

Correct answer: (C) Favourite ice cream flavours. Favourite ice cream flavours are qualitative (nominal) data, since they are categories/labels rather than numeric measurements.

What type of data involves distinct, separate values that are countable? (A) Nominal Data (B) Ordinal Data (C) Discrete Data (D) Continuous Data

Correct answer: (C) Discrete Data. Discrete data consists of distinct, separate, countable values, often expressed as whole numbers.

What is an example of continuous data? (A) Number of cars in a parking lot (B) Height of students in centimetres (C) Types of fruits (D) Shirt sizes (small, medium, large)

Correct answer: (B) Height of students in centimetres. Height in centimetres is continuous data because it can take any value within a range, including decimals.

What type of data is used to categorize items without implying any order? (A) Ordinal Data (B) Discrete Data (C) Nominal Data (D) Continuous Data

Correct answer: (C) Nominal Data. Nominal data is used to label or categorize items without implying any specific order between the categories.

How can you organise data to make it easier to analyse? (A) By writing it in long paragraphs (B) By creating tables, charts, and graphs (C) By storing it in random files (D) By keeping it in a messy notebook

Correct answer: (B) By creating tables, charts, and graphs. Organizing data into tables, charts, and graphs makes it much easier to compare, interpret, and analyze.

Which tool can be used to create surveys online? (A) Microsoft Word (B) Google Forms (C) Excel Spreadsheets (D) Adobe Photoshop

Correct answer: (B) Google Forms. Google Forms is a free online tool specifically designed for creating surveys and collecting responses.

What is the primary purpose of data visualization? (A) To generate random numbers (B) To convert text into data (C) To make data easier to understand by turning it into pictures (D) To hide complex data
Correct answer: (C) To make data easier to understand by turning it into pictures. Data visualization turns numbers and information into pictures (charts, graphs) to make patterns and trends easier to understand.

What is the first step in the data science process? (A) Data Cleaning (B) Data Analysis (C) Data Collection (D) Understanding the problem
Correct answer: (D) Understanding the problem. Problem Identification (understanding and clearly defining the problem) is the first step in the Data Science Workflow.

What does the 'Volume' characteristic of Big Data refer to? (A) The speed at which data is generated (B) The different forms data can take (C) The sheer amount of data being collected (D) The way data is processed
Correct answer: (C) The sheer amount of data being collected. Volume refers to the sheer amount of data being collected, one of the Three Vs (Volume, Velocity, Variety) that define Big Data.

Quick Revision Summary

- 2 broad data categories: Qualitative (non-numeric) and Quantitative (numeric)
- 4 sub-types: Nominal, Ordinal (qualitative); Discrete, Continuous (quantitative)
- 4 storage technologies: Spreadsheets, Databases, Data Warehouses, NoSQL
- Visualization by type: Nominal→bar/pie; Ordinal→bar/stacked bar; Discrete→histogram/dot plot; Continuous→line/scatter/box plot
- Measures of centre: Mean, Median, Mode; Measures of spread: Range, Variance, Standard Deviation
- Data pre-processing: evaluate quality → identify errors/outliers/bias → validate → clean

- Data Science Workflow: Problem ID → Collection → Cleaning → Analysis → Interpretation → Visualization
- Big Data's 3 Vs: Volume (amount), Velocity (speed), Variety (different forms)

Exam Tips

- Remember: Qualitative = Quality (words/labels); Quantitative = Quantity (numbers)
- Nominal has NO order; Ordinal HAS order — remember 'Ordinal = Ordered'
- Discrete = countable whole numbers (how many); Continuous = any value in a range, including decimals (how much/long)
- Mean is affected by outliers; Median is not — use median when data has extreme values
- Standard deviation is just the square root of variance — always compute variance first
- Big Data's 3 Vs: Volume, Velocity, Variety — a very common exam question