Introduction Into Data Types

Course:

INFO-6145 Data Science and Machine Learning

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Main Categories of Data Types

There are two main categories of data in data science:

- **Quantitative Data (Numeric):** Represents measurable quantities.
- **Qualitative Data (Categorical):** Represents categories or labels.

Each category has its own subcategories, which we will explore in detail.

Quantitative Data (Numeric)

Quantitative data is numerical and represents measurable quantities. It is divided into two subcategories:

- **Discrete Data:** Can only take specific, countable values.
- **Continuous Data:** Can take any value within a range.

Examples

Discrete: Number of children in a family, Number of students in a class
Continuous: Distance traveled by a vehicle, height, temperature.

Qualitative Data (Categorical)

Qualitative data represents groups or categories. It is divided into two subcategories:

- **Nominal Data:** Categories with no inherent order.
- **Ordinal Data:** Categories with a specific order.

Examples

Nominal: Types of pets (dog, cat, bird), colors (red, blue, green).
Ordinal: Education level (high school, bachelor's, master's), ratings (poor, fair, good).

Binary Data

Binary data is a specific type of categorical data with only two possible values.

- Typically represents "yes/no" or "true/false" outcomes.
- Used in classification tasks where there are two possible outcomes.

Examples

Does a customer purchase a product? (Yes/No)
Is the user subscribed to the newsletter? (True/False)

Structured vs. Unstructured Data

Structured Data: Highly organized and easily searchable, usually found in databases or spreadsheets.
Unstructured Data: Lacks a defined format, making it harder to analyze (e.g., text, images, video, audio).

Examples

Structured: Customer transaction data in tables.
Unstructured: Social media posts, emails, images, or videos.

Time Series Data

Time series data involves observations collected at regular intervals over time.

Key Characteristics

Time series data is used to analyze patterns, trends, and seasonality over time.

Examples

Stock market prices recorded daily.
Temperature measurements taken every hour.

Image Data

Image data consists of pixels organized in a grid format, where each pixel holds information like color intensity.

Key Characteristics

Image data can be used for tasks such as classification, detection, and recognition. It is high-dimensional and requires special techniques for processing, like convolutional neural networks (CNNs).

Examples

Medical scans (X-rays), facial recognition images, satellite images.

Video Data

Video data consists of sequences of images (frames) captured over time.

Key Characteristics

Each frame of a video is essentially image data, but video data also incorporates time as a key factor. Video data is used in tasks like action recognition and object tracking.

Examples

Security camera footage, video streaming services (e.g., YouTube).

Text Data

Text data refers to data in the form of words or sentences, and is typically unstructured.

Key Characteristics

Text data requires natural language processing (NLP) techniques for tasks like sentiment analysis, language translation, and information retrieval. It's used extensively in chatbots, virtual assistants, and social media analysis.

Examples

Product reviews, news articles, social media posts.

Summary of Data Types

- **Numeric Data:** Quantitative data (e.g., age, income).
- **Categorical Data:** Qualitative data (e.g., gender, education level).
- **Binary Data:** Yes/No, True/False outcomes (e.g., purchase status).
- **Time Series Data:** Data indexed over time (e.g., stock prices).
- **Image Data:** Pixel-based data (e.g., X-rays, facial recognition).
- **Video Data:** Sequences of frames over time (e.g., surveillance footage).
- **Text Data:** Words and sentences (e.g., product reviews, articles).

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Quantitative Data (Numeric) - Questions

Questions

- How can we collect data to predict a car's fuel efficiency based on engine size?
- What data set is needed to measure the annual rainfall across different cities?
- How can we estimate the growth of a tree based on its age and height?
- What type of data is required to track the number of products sold monthly in a store?
- How would you collect data to determine the relationship between income and expenditure?

Quantitative Data (Numeric) - Answers

Answers

- Engine size (continuous) for predicting fuel efficiency.
- Annual rainfall (continuous) for different cities.
- Age and height (continuous) for tree growth estimation.
- Monthly sales (discrete) for tracking product sales.
- Income and expenditure (continuous) for relationship analysis.

Qualitative Data (Categorical) - Questions

Questions

- What kind of data can be collected to categorize employees by department?
- How can we collect data to group survey responses by education level?
- What data would help in identifying different species of plants in a garden?
- How can we classify cars by brand in a dealership database?
- What kind of data set is required to categorize products by type (e.g., electronics, clothing)?

Qualitative Data (Categorical) - Answers

Answers

- Department (nominal) for classifying employees.
- Education level (ordinal) for survey responses.
- Species (nominal) for plant identification.
- Car brand (nominal) for dealership classification.
- Product type (nominal) for product categorization.

Binary Data - Questions

Questions

- How can we collect data to determine if a customer will renew their subscription?
- What data would you collect to assess whether a student passed or failed an exam?
- How can you determine if a person is a smoker or non-smoker for a health study?
- What data can be used to classify customer feedback as positive or negative?
- How can we categorize whether a bank transaction is fraudulent or not?

Binary Data - Answers

Answers

- Subscription renewal status (Yes/No).
- Exam results (Pass/Fail).
- Smoking status (Smoker/Non-smoker).
- Feedback sentiment (Positive/Negative).
- Transaction status (Fraud/Non-fraud).

Structured vs. Unstructured Data - Questions

Questions

- How can we store and analyze customer transaction data in a structured format?
- What type of data can be used to study sentiment from social media posts?
- What data do we need to classify emails based on subject and content?
- How can we store and retrieve video surveillance data for crime detection?
- What type of data is required to analyze customer feedback from support tickets?

Structured vs. Unstructured Data - Answers

Answers

- Use structured tables for customer transactions.
- Social media text (unstructured) for sentiment analysis.
- Email subject (structured) and content (unstructured) for classification.
- Video data (unstructured) for crime detection analysis.
- Text data (unstructured) from support tickets for feedback analysis.

Time Series Data - Questions

Questions

- What data would you collect to forecast weather conditions?
- How can we gather data to track a machine's performance over time?
- What data can be used to analyze the monthly sales trend for a retail store?
- How would you collect data to predict the next day's electricity consumption in a household?
- What data set is needed to monitor a stock's price changes throughout the day?

Time Series Data - Answers

Answers

- Weather data (time series) for weather forecasting.
- Machine sensor data (time series) for performance tracking.
- Monthly sales data (time series) for trend analysis.
- Daily electricity consumption (time series) for consumption prediction.
- Stock price data (time series) for daily price monitoring.

Image Data - Questions

Questions

- What data can be collected to train a model to detect objects in an image?
- How would you collect data to develop a facial recognition system?
- What type of data is required to analyze medical scans for detecting abnormalities?
- How can you gather data to classify different types of animals in wildlife images?
- What data is needed to identify damaged products in an image database?

Image Data - Answers

Answers

- Image data for object detection.
- Facial image data for recognition systems.
- Medical scan images for abnormality detection.
- Wildlife image data for animal classification.
- Product image data for damage identification.

Video Data - Questions

Questions

- How would you collect data to detect human activity in a surveillance video?
- What type of data is required to track moving objects in a video feed?
- How can you collect data to classify actions in sports videos?
- What data do we need to analyze security camera footage for anomaly detection?
- How would you gather data for analyzing traffic flow from road surveillance cameras?

Video Data - Answers

Answers

- Surveillance video data for human activity detection.
- Video frames for object tracking.
- Sports video data for action classification.
- Security footage for anomaly detection.
- Road surveillance video for traffic flow analysis.

Text Data - Questions

Questions

- What type of data can be used to analyze customer reviews for sentiment?
- How can you collect data to classify emails as spam or not spam?
- What data set is required to categorize product descriptions by type?
- How can you gather data to summarize long news articles automatically?
- What type of data is needed to perform text-based customer feedback analysis?

Text Data - Answers

Answers

- Text data (customer reviews) for sentiment analysis.
- Email content (text data) for spam classification.
- Product descriptions (text data) for product categorization.
- Text from articles for automated summarization.
- Customer feedback text for feedback analysis.