Characteristics of Different Data Management Methods

1. Relational Databases (RDBMS)

- **Pros**:
    - Structured data with strict schema.
    - ACID compliance ensures data consistency.
    - Mature technology with wide tool and developer support.
- **Cons**:
    - Less suited for unstructured or semi-structured data.
    - Scaling horizontally can be challenging.
- **Examples**: MySQL, PostgreSQL, Oracle Database.

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2. NoSQL Databases

- **Pros**:
    - Designed for scalability and flexibility.
    - Suitable for unstructured/semi-structured data.
    - High performance for specific workloads (e.g., document or graph queries).
- **Cons**:
    - May sacrifice ACID compliance for scalability (CAP theorem).
    - Less standardized compared to RDBMS.
- **Types and Examples**:
    - **Document Stores**: MongoDB, CouchDB.
    - **Column Stores**: Apache Cassandra, HBase.
    - **Key-Value Stores**: Redis, DynamoDB.
    - **Graph Databases**: Neo4j, ArangoDB.

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3. Data Warehouses (DW)

- **Pros**:
    - Optimized for analytics and querying historical data.
    - Integrates data from multiple sources.
    - Supports complex querying and business intelligence.
- **Cons**:

    - Not designed for real-time data updates.
    - Setup and maintenance can be resource-intensive.
- **Examples**: Amazon Redshift, Snowflake, Google BigQuery.

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4. ELT/ETL Pipelines

- **Pros**:
    - Handles data integration from diverse sources.
    - Transforms raw data into usable formats.
    - Supports both batch and stream processing.
- **Cons**:
    - Requires robust pipeline design to handle failures and data quality issues.
- **Examples**: Apache Airflow, Talend, Azure Data Factory.

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5. Big Data Frameworks

- **Pros**:
    - Handles massive datasets with distributed processing.
    - Scalable for both batch and stream processing.
- **Cons**:
    - High setup complexity and resource requirements.
- **Examples**:
    - **Batch Processing**: Hadoop.
    - **Stream Processing**: Apache Kafka, Apache Spark.

Key Terms and Acronyms in Data Management

- **ACID**: Atomicity, Consistency, Isolation, Durability (RDBMS transactions).
- **CAP Theorem**: Trade-off among Consistency, Availability, and Partition Tolerance.
- **ETL/ELT**: Extract, Transform, Load (ETL) or Extract, Load, Transform (ELT) pipelines.
- **Polyglot Persistence**: Using multiple types of databases (e.g., RDBMS + NoSQL) for different tasks in the same system.
- **OLTP/OLAP**: Online Transaction Processing (OLTP) for real-time queries; Online Analytical Processing (OLAP) for historical analysis.

How to Approach a Data Collection and Storage Task

Questions to Ask:

1. **Purpose**:
    - What is the primary goal of collecting this data (e.g., reporting, analytics, real-time decision-making)?
2. **Data Characteristics**:
    - What types of data will be collected? (structured, semi-structured, unstructured)
    - What volume and velocity of data are expected?
3. **Integration Needs**:
    - Will the data need to interact with other systems? How will it be ingested?
4. **Retention and Compliance**:
    - How long must the data be stored?
    - Are there legal or regulatory requirements (e.g., GDPR)?
5. **Access Patterns**:
    - Who needs to access the data, and how (real-time vs. batch)?
6. **Scalability**:
    - How will the system handle growth in data volume or user base?

Attributes to Look For:

- **Data Quality**: Accuracy, completeness, and consistency.
- **Scalability**: Ability to grow with the data and user needs.
- **Performance**: Speed of queries and data access.
- **Security**: Controls to protect data integrity and access.
- **Cost**: Storage and computational costs, considering trade-offs.

Polyglot Persistence: A Multi-Part Solution

Modern data systems often use **polyglot persistence**, where multiple types of databases are used in tandem to meet diverse needs:

Example Use Case:

A large e-commerce platform might use:

1. **Relational Database**: For transactional data like orders and inventory (e.g., PostgreSQL).
2. **Document Store**: For user profiles and session data (e.g., MongoDB).
3. **Graph Database**: To analyze relationships, such as customer preferences or product recommendations (e.g., Neo4j).
4. **Data Warehouse**: For analytics and reporting (e.g., Snowflake).

Why Use Polyglot Persistence?

- Each database type excels at specific tasks.
- Allows organizations to optimize for performance, scalability, and cost.

Summary

Choosing the right data management method involves understanding the data's volume, velocity, and variety, as well as the application's requirements. The combination of different technologies (polyglot persistence) allows for tailored solutions, balancing performance, scalability, and cost efficiency.