OLAP (Online Analytical Processing)

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OLAP Overview

- **OLAP (On-Line Analytical Processing)**.
- OLAP is a classification of software technology which authorizes analysts, managers, and executives to gain insight into information through fast, consistent, interactive access in a wide variety of possible views of data that has been transformed from raw information to reflect the real dimensionality of the enterprise as understood by the clients.

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OLAP Overview

- **OLAP** implement the multidimensional analysis of business information and support the capability for complex estimations, trend analysis, and sophisticated data modeling.
  - It is an essential foundation for Intelligent Solutions containing Business Performance Management, Planning, Budgeting, Forecasting, Financial Documenting, Analysis, Knowledge Discovery, and Data Warehouses Reporting.

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OLAP Overview

- OLAP enables end-clients to perform ad hoc analysis of record in multiple dimensions, providing the insight and understanding they require for better decision making.

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Who uses OLAP and Why?

- OLAP applications are used by a variety of the functions of an organization.
- **Finance and accounting:**
  - Budgeting
  - Activity-based costing
  - Financial performance analysis
  - And financial modeling

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Who uses OLAP and Why?

- **Sales and Marketing**
  - Sales analysis and forecasting
  - Market research analysis
  - Promotion analysis
  - Customer analysis
  - Market and customer segmentation
- **Production**
 - Production planning
  - Defect analysis

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Who uses OLAP and Why?

- Analysts frequently need to group, aggregate and join data.
- OLAP operations in data mining are resource intensive.
- OLAP data can be pre-calculated and pre-aggregated, making analysis faster.
- OLAP databases are divided into one or more cubes.
  - The cubes are designed in such a way that creating and viewing reports become easy

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OLAP cube
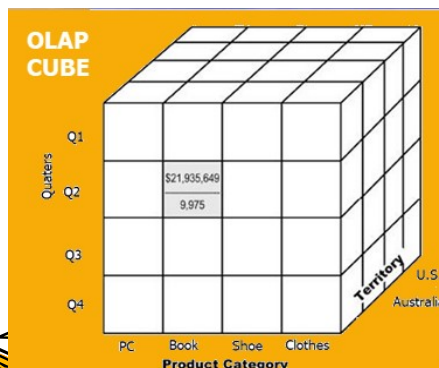
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OLAP cube

- At the core of the OLAP concept, is an OLAP Cube. The OLAP cube is a data structure optimized for very quick data analysis.
- The OLAP Cube consists of numeric facts called measures which are categorized by dimensions. OLAP Cube is also called the **hypercube**.

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OLAP cube

- Usually, data analysis are performed using the spreadsheet, where data values are arranged in row and column format.
- This is ideal for two-dimensional data.
- However, OLAP contains multidimensional data, with data usually obtained from a different and unrelated source.

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OLAP cube

- Using a spreadsheet is not an optimal option.
- The cube can store and analyze multidimensional data in a logical and orderly manner.

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How does it work?

- A Data warehouse would extract information from multiple data sources and formats like text files, excel sheet, multimedia files, etc.
- The extracted data is cleaned and transformed.
- Data is loaded into an OLAP server (or OLAP cube) where information is pre-calculated in advance for further analysis.

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Basic analytical operations of OLAP

- Four types of analytical OLAP operations are:
  - Roll-up
  - Drill-down
  - Slice and dice
  - Pivot (rotate)

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Roll-up

- Roll-up is also known as "consolidation" or "aggregation."
- The Roll-up operation can be performed in 2 ways
  - Reducing dimensions
  - Climbing up concept hierarchy.
    - Concept hierarchy is a system of grouping things based on their order or level.
- Consider the following diagram

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Roll-up operation in OLAP

- In this example, cities New jersey and Lost Angles and rolled up into country USA
- The sales figure of New Jersey and Los Angeles are 440 and 1560 respectively. They become 2000 after roll-up
- In this aggregation process, data is location hierarchy moves up from city to the country.
- In the roll-up process at least one or more dimensions need to be removed.
  - In this example, Cities dimension is removed.

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Drill-down

- In drill-down data is fragmented into smaller parts.
- It is the opposite of the rollup process.
- It can be done via
  - Moving down the concept hierarchy
  - Increasing a dimension

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Drill-down

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Drill-down

- Consider the diagram above
  - Q1 is drilled down to months January, February, and March.
  - Corresponding sales are also registers.
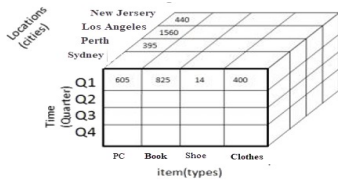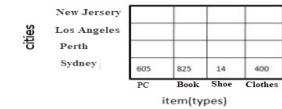- In this example, dimension months are added.

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Slice

- Here, one dimension is selected, and a new sub-cube is created.
- Following diagram explain how slice operation performed:
- Slice operation in OLAP
  - Dimension Time is Sliced with Q1 as the filter.
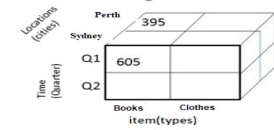 - A new cube is created altogether.
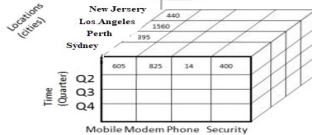
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Slice

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Dice:

- This operation is similar to a slice. The difference in dice is you select 2 or more dimensions that result in the creation of a sub-cube.
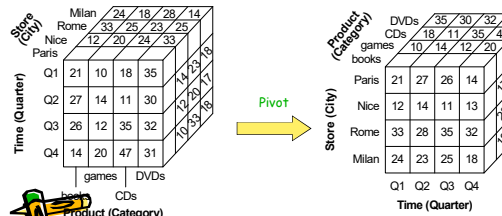
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Dice operation in OLAP
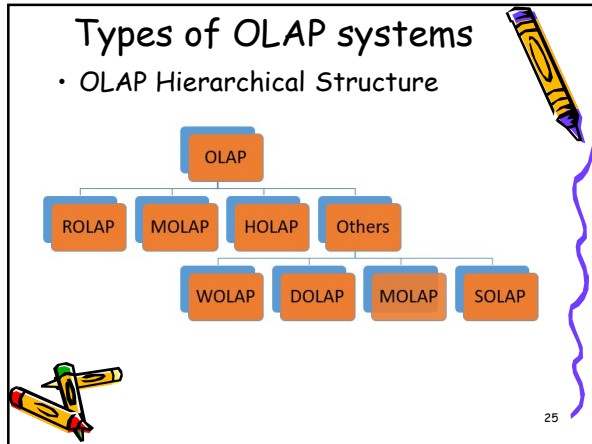

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Pivot or Rotate

- Rotates the axes of a cube to provide an alternative presentation of the data

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Types of OLAP systems

- OLAP Hierarchical Structure

```
                    OLAP
        ┌──────┬──────┬──────┐
     ROLAP  MOLAP  HOLAP  Others
                    ┌──────┬──────┬──────┐
                 WOLAP  DOLAP  MOLAP  SOLAP
```

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Types of OLAP systems

- Relational OLAP (ROLAP): Store data in relational databases, support extensions to SQL and special access methods to efficiently implement the model and its operations

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Types of OLAP systems

- Multidimensional OLAP (MOLAP): Store data in special data structures (e.g., arrays) and implement OLAP operations in these structures
  - Better performance than ROLAP for query and aggregation, less storage capacity than ROLAP
- Hybrid OLAP (HOLAP): Combine both technologies,
  - E.g., detailed data stored in relational databases, aggregations kept in a separate MOLAP store

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Questions