DATA WAREHOUSE DIMENSIONS

Lecture 5

DIMENSION TABLES

Always has primary key (PK)

Poduct ID	Name	Category
P001	Sun Glases TR-7	Assecoirs
P002	Chocolate bar 70% cacao	Sweets
P003	Oat meal biscuits	Sweets

Produkt_PK	Name	Category
1	Sun Glases TR-7	Assecoirs
2	Chocolate bar 70% cacao	Sweets
3	Oat meal biscuits	Sweets

Use of Surrogate Keys

Produkt_PK	Product_ID
1	P001
2	P002
3	P003

- **Dimension Tables**
  - Function: Used to slice and dice data
- **Properties of a Dimension Table**
  - Always needs a primary key
    - Natural key from the source system is available
    - Natural key is not the best choice for a primary key
    - Recommendation: Use surrogate keys
      - Usually an incrementing integer
      - Surrogate keys have more benefits

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Use of Surrogate Keys

- Question: Do we need to keep the natural keys?
  - Answer: We can, but it is often not necessary
- Recommendation: Use a lookup table
  - Reference: Links the created surrogate key with the natural key

Implementing a Lookup Table

- SQL query: Retrieve distinct values of the product ID (natural key)
- Add sequence: Populate a sequence next to these values
  - Easily done in SQL or other ETL tools

HOW TO CREATE CORRECT REFERENCES FROM FACT TABLE TO DIMENSION TABLE USING SURROGATE KEYS?

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Use of Surrogate Keys

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- **Typical Example Scenario: Fact Table**
  - Origin: Fact table comes from the source system.
  - Issue: Fact table still contains the natural key.

  - **Solution: Using a Lookup Table or Joins**

  - **Lookup Table Approach**
    - Use the lookup table to map natural keys to surrogate keys.

  - **Join Approach**
    - Retain both surrogate and natural keys in the table.
    - Create a join between fact and dimension tables.

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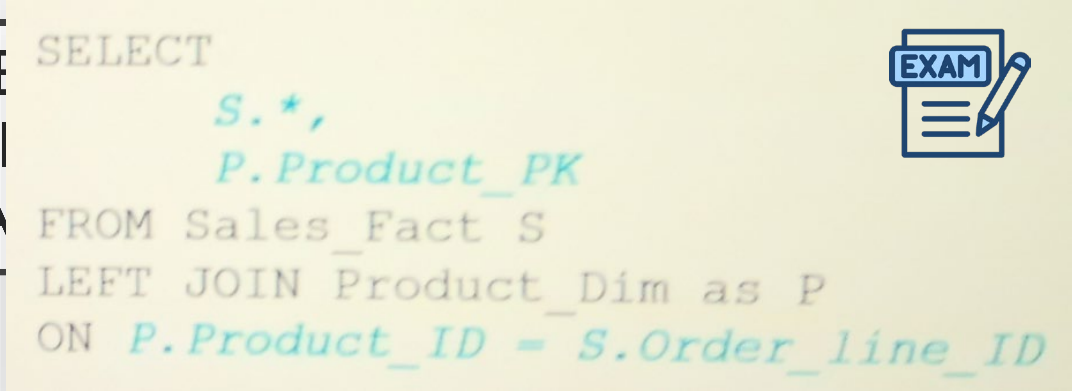

```
SELECT
        S.*,
        P.Product_PK
FROM Sales_Fact S
LEFT JOIN Product_Dim as P
ON P.Product_ID = S.Order_line_ID
```

- **Implementing a Join in SQL**
- Start with the original fact table.
  - Includes all attributes already created and transformed.
  - Replacing the natural key is usually the last step after transformations.
- **Example of SQL Join**
  - Use a left join from the sales fact table to the product dimension table.
  - Aliases for Tables: P for product dimension, S for sales fact.
  - Join Columns: Use product ID from the lookup or dimension table and order line ID from the sales table.
- **Process**
  - Add the value from the product table using the join.
  - Replace natural key values with surrogate key values.
  - Example: Replace P034 with 34 from the product or lookup table.

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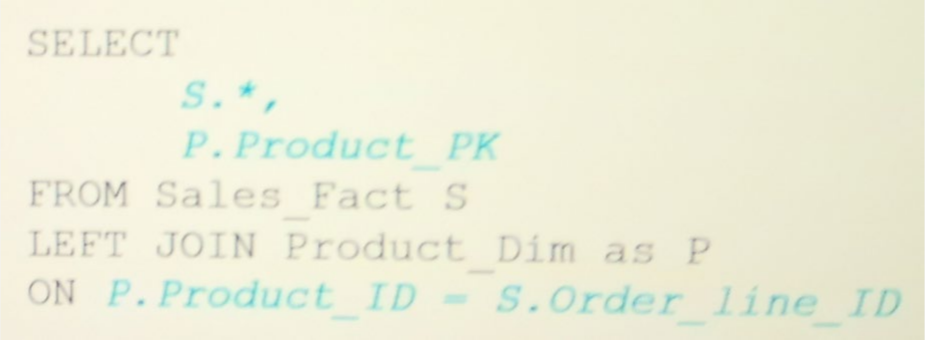

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      P.Product_PK
FROM Sales_Fact S
LEFT JOIN Product_Dim as P
ON P.Product_ID = S.Order_line_ID
```

- **Alternative Methods**
  - Other methods can be used, but joins are common.
  - Example: Removing prefix (e.g., P) and transforming the key to an integer.
  - Common method: Left join to ensure all matches.

- **Final Result**
  - Achieve correct references to the dimension table.
  - Ensure accurate and efficient data slicing and dicing.

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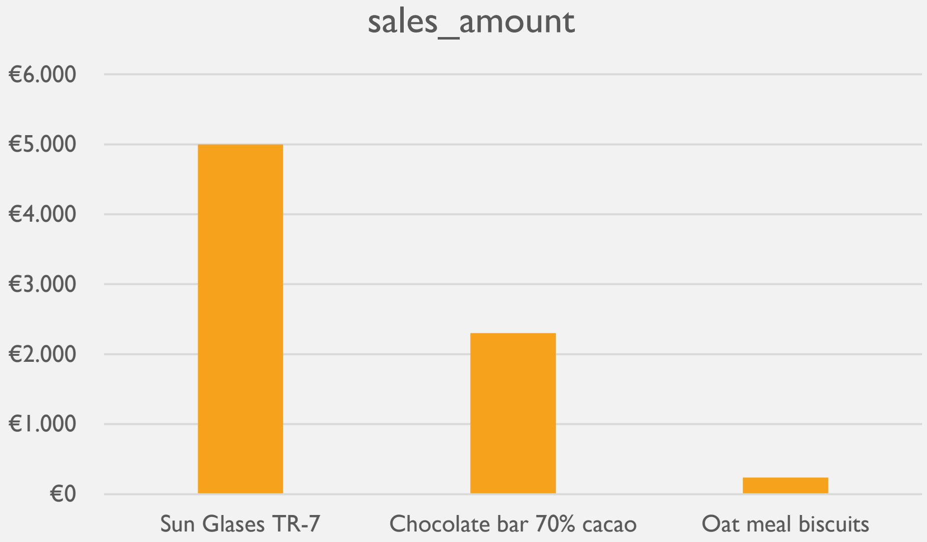
Cusomer_ ID	Customer_Na me	Order_ ID	Order_Line_ID	Order_Line_ FK	Quanti ty	UnitPri ce	Disc oujt _Pri ce
312	Johannes Strass	2345	Sun Glases TR-7	1	2	23.99	23.9 9
312	Johannes Strass	2314	Chocolate bar 70% cacao	156	3	8.99	8.99
312	Johannes Strass	2314	Oat meal biscuits	643	1	16.99	16.9 9

Relatively few rows / many columns With deseriptive attribute

- **Dimension Table Utilization**
  - Create a correct reference from the product primary key in the fact table.
  - Ensure it refers to the correct values.
- **Example Scenario: Sunglasses TR7**
  - Order line one references:
    - Correct product name (e.g., Sunglasses TR7)
    - Related attributes (e.g., category, subcategory)
- **Optimization**
  - Remove product name and attributes from the fact table.
  - Use the dimension table for all descriptive attributes.
- **Dimension Table Characteristics**
  - Typically has fewer rows.
  - Wide table with many columns for different descriptive attributes.

USE OF DIMENSION IN ANLYSIS

Order_Line_name	sales_amount
Sun Glases TR-7	5.000 €
Chocolate bar 70% cacao	2.300 €
Oat meal biscuits	234 €



- **Learning Outcome**
  - Dimension tables are used to group and filter data.
  - Known as "slicing and dicing" the data.
- **Functionality**
  - Use attributes of the dimension table for grouping data.
  - Example: Group data by product name.
- **Data Analysis**
  - Dimension tables serve as the entry point for data analysis.
  - Crucial for effective data analysis due to their structure and functionality.
- **Significance of Dimensions**
  - Essential for organizing and interpreting data.
  - Enhance the ability to analyze and draw insights from data.

DATE DIMENSION

- **Common Usage**
  - Most commonly used dimension in data processes.
  - Almost always available in data warehouses.

- **Importance in Analysis**
  - Crucial for measuring performance over time.
  - Key aspect of dimensional analysis.

Date Dimension

- One of the most common & most important dimensions
- Contains date related features
  - • Year, Month (name & number), Day, Quarter, Week,
  - Weekday (name & number)
- Meaningful surrogate key
  - For example 2022-04-02 20220402
- Extra row for no date/null (source) 1900-01-01 (dim)

DATE DIMENSION
ATTRIBUTES OF THE DATE DIMENSION

- **Basic Attributes**
  - Year
  - Month (both name and number)
  - Day in the month
  - Quarter
  - Week
  - Day of the week (both as text and number)
- **Examples**
  - Monday = 1, Tuesday = 2, etc.

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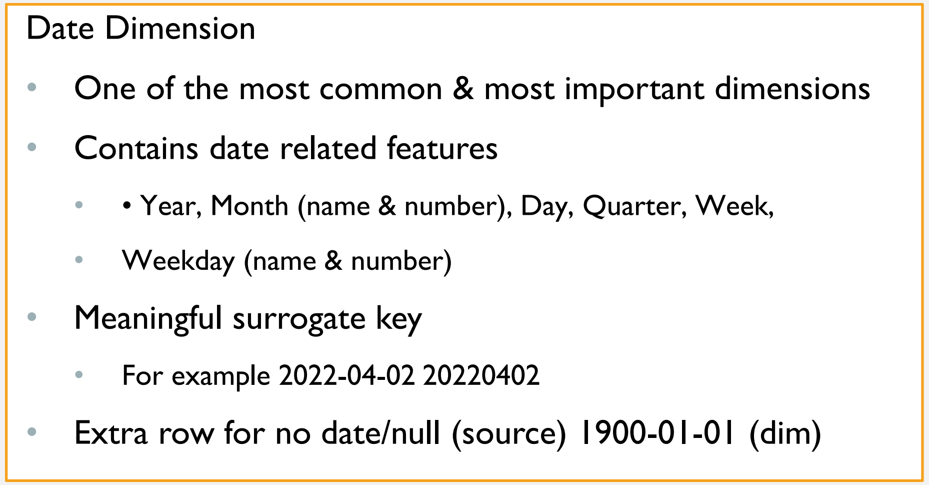
DATE DIMENSION
Surrogate Key in the Date Dimension

- **Meaningful Surrogate Key**
  - Not a simple incrementing number.
  - Consists of year, month, and day (e.g., 20220402 for April 2, 2022).
  - Serves as the primary key in the date dimension.

- **Handling Missing Dates**

- **Dummy Value Row**
  - Extra row representing a dummy value for missing dates.
  - Ensures no null values in foreign keys within the fact table.
  - Common dummy date: January 1, 1900.



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DATE DIMENSION
Ensuring Referential Integrity

- **Replacing Null Values**
  - Replace null or missing date values with the dummy foreign key.
  - Maintains referential integrity and relationships.

- **Conclusion**
  - Proper setup of the date dimension is crucial for accurate and efficient data analysis.

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ADDING TIME GRANULARITY AND ENHANCING THE DATE DIMENSION

Separate Time Dimension

- **Importance of Time Aspect**
  - If timestamps are important, separate time dimension is needed.
  - Granularity of time should be considered separately from the date.
- **Time Dimension**
  - Create a separate dimension for time when necessary.

Date Dimension Characteristics

- **Predictability and Calculation**
  - Date dimension is predictable and can be populated in advance.
  - Can include future dates not yet in the fact table.
- **Future Dates**
  - Populate the date dimension for upcoming years.

Date Dimension

- Time is usually a separate dimension
- Can be populated in advance (e.g. for next 5 or 10 years)
  - Numbers & Text (e.g. January, 1)
  - Long & Abreviated (Jan, January— Mon, Monday)
  - Combinations of attributes (Q1, 2022-Q1)
  - Fiscal dates (Fiscal Year etc.)
  - Flags (Weekend, company holidays etc.)

ADDING TIME GRANULARITY AND ENHANCING THE DATE DIMENSION

- **Components of a Date Dimension**
  - **Attributes to Include**
    - Both numbers and text (e.g., January and 1 for the first month).
    - Long and abbreviated names (e.g., January and Jan).
  - **Business Use Case**
    - Include attributes based on business requirements.
    - Abbreviated names for reporting purposes.

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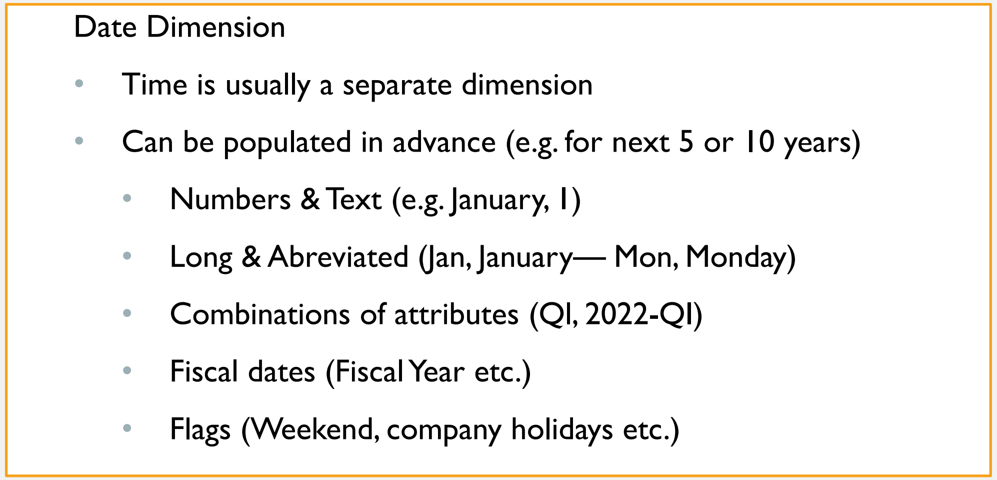
ADDING TIME GRANULARITY AND ENHANCING THE DATE DIMENSION
Combination Attribute

- **Examples**
  - Quarter and year combination (e.g., 2022 Q1).
  - Simplifies data grouping for end users.

- **Fiscal Dates**
  - Include fiscal year information.



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ADDING TIME GRANULARITY AND ENHANCING THE DATE DIMENSION
Flags and Indicators

- **Usage**
  - Flags indicate if a condition is true or not.
  - Examples: Is it a weekend? Is it a holiday?

- **Analysis**
  - Use flags for detailed data analysis.

- **Conclusion**
  - A well-structured date dimension enhances data analysis capabilities.
  - Including comprehensive and relevant attributes facilitates easier and more effective reporting.

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EXAMPLE OF A DATE TABLE

- **Primary Key**
  - The first and most important column in the date table.
- **Original Date**
  - The base date value, typically always available.
  - Stored as a date data type.
- **Note on Formatting**
  - Different formats (hyphens, backslashes) are handled in the BI application, not in the database.

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Date_FK	Date	Month	Short_Month	Year-Quarter	Year	Weekend	Is_Week
20240101	2022-01-01	January	Jan	2024-Q1	2024	Saturday	1
20240102	2022-01-02	January	Jan	2024-Q1	2024	Sunday	1
20240103	2022-01-03	January	Jan	2024-Q1	2024	Monday	0

EXAMPLE OF A DATE TABLE

- **Combination and Abbreviated Values**
  - Include both long and abbreviated forms of dates.
  - Example: January (full name) and Jan (abbreviation).

- **Flags and Indicators**
- **Weekend Indicator**
  - Flag to indicate if the date is a weekend.
  - Saturday and Sunday are weekends (value = 1).
  - Monday through Friday are weekdays (value = 0).

- **Binary Flag Usage**
  - Advantages: Can be aggregated, summed, and used in calculations.
  - Disadvantages: Less user-friendly.
  - Alternative: Use understandable text (e.g., "weekend" or "weekday").

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EXAMPLE OF A DATE TABLE

- **User Considerations**
  - Choose flag representations based on business user needs and reporting requirements.

- **Conclusion**
  - The date dimension is crucial and must be designed with attention to detail, considering both functionality and user-friendliness.

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NULL IN DIMENSTIONS
RECAP ABOUT NULLS

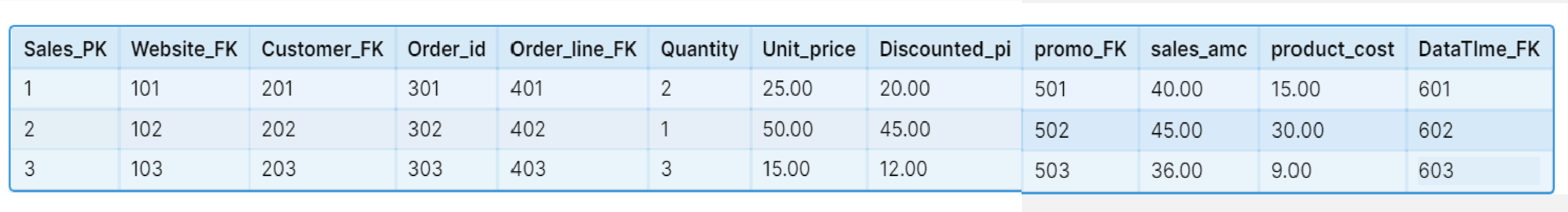
- **Nulls in Foreign Keys**
  - Must be avoided to maintain referential integrity.
  - Replace nulls with a dummy value (e.g., -1).

- **Consequences of Nulls**
  - Nulls in foreign keys break joins and relationships.
  - Results in loss of values during joins with dimension tables.
  - Example: Grouping by promotion type would miss values with nulls.

- **Using Dummy Values**
  - Replace nulls with a dummy value (e.g., -1) to preserve data in joins.
  - Include a corresponding row in the dimension table (e.g., "No Promo" for promotion type).

Promo _PK	Social media prom
Newsletter	1
Website ads	2
No promo	3
Promo name	-1

Date_PK	Date
20220101	1/1/2022
20220102	1/2/2022
20220103	1/3/2022
19000101	1/1/1900



Sales_PK	Website_FK	Customer_FK	Order_id	Order_line_FK	Quantity	Unit_price	Discounted_pi	promo_FK	sales_amc	product_cost	DataTIme_FK
1	101	201	301	401	2	25.00	20.00	501	40.00	15.00	601
2	102	202	302	402	1	50.00	45.00	502	45.00	30.00	602
3	103	203	303	403	3	15.00	12.00	503	36.00	9.00	603

NULLS IN FACT TABLES

Promo_PKz	Social media prom
Newsletter	1
Website ads	2
No promo	3
Promo name	-1

Date_PK	Date
20220101	1/1/2022
20220102	1/2/2022
20220103	1/3/2022
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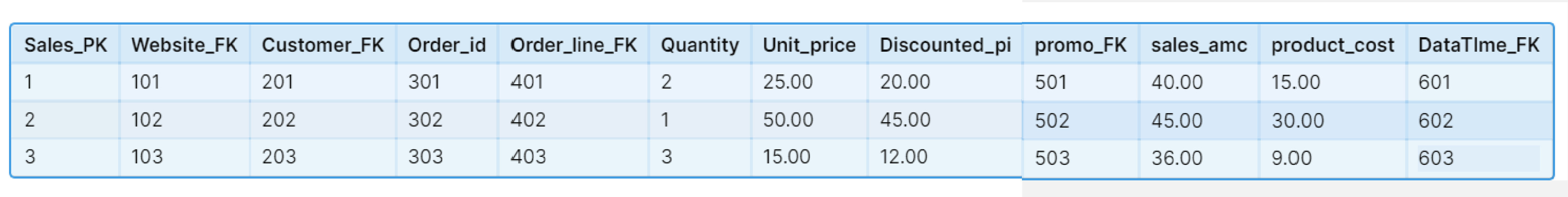
- **Nulls in Fact Tables**
  - **Appropriate Use**
    - Nulls can be present in fact tables for valid scenarios.
    - Example: No sales on weekends if stores are closed.
    - Using zero instead of null could distort averages and sums.
  - **Aggregation Compatibility**
    - Nulls work well with aggregations like sum and average.
    - Do not necessarily need to replace nulls in fact tables.



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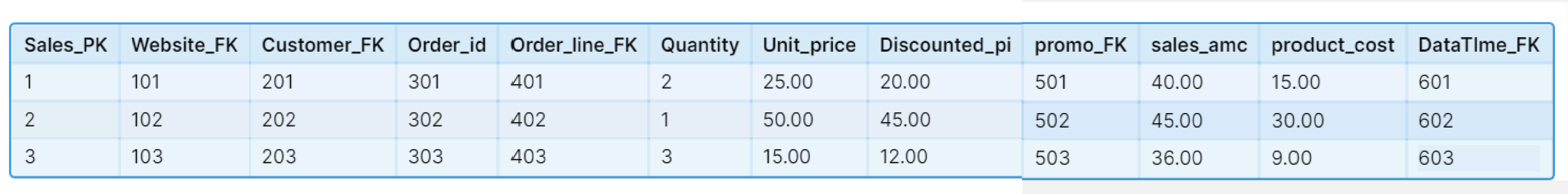
- **Key Takeaways**
  - **Foreign Keys**
    - Avoid nulls in foreign keys; use dummy values.
    - Ensure dummy values are properly represented in dimension tables.
  - **Fact Tables**
    - Nulls can be acceptable and useful for certain aggregations.
    - Replace nulls with meaningful values only when necessary to maintain data accuracy.



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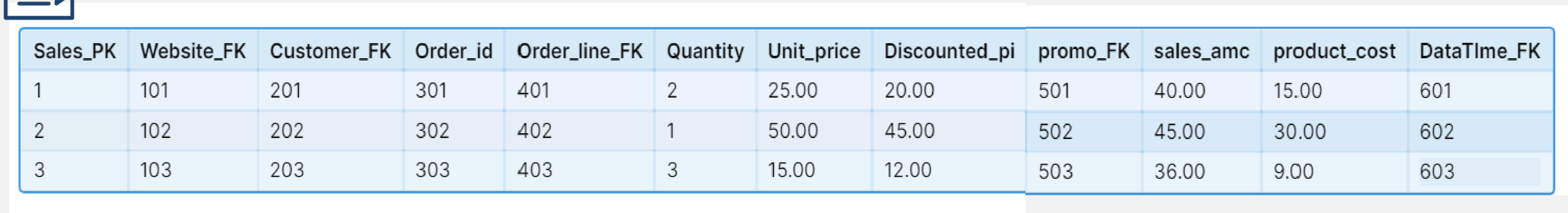
NULLS IN DIMENSION TABLES



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3	103	203	303	403	3	15.00	12.00	503	36.00	9.00	603

Nulls must be avoided in FKs

- **Maintaining Referential Integrity**
  - Dimension tables should include a row for the dummy value.
  - Example for Date Dimension: Use 1st January 1900 as a dummy date.

Promo_PK	Social media prom
Newsletter	1
Website ads	2
No promo	3
Promo name	-1

Date_PK	Date
20220101	1/1/2022
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NULLS IN DIMENSION

- **Replacing Nulls**
  - Replace nulls in dimensions with descriptive values.
  - Example: "No promotion available", "No category available".
  - Use dummy values like 1st January 1900 for dates.

Promo_PK	Social media prom
Newsletter	1
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Promo name	-1

Date_PK	Date
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- **Reasoning Behind Replacement**
  - Improve clarity for business users.
  - Nulls lack descriptive context, potentially confusing.
  - Descriptive values help users understand the absence of data.

- Replace nulls With descriptive values
  - More understable for business users
  - Values appear in aggregations in BI tools

IMPLEMENTATION STRATEGY

- **User Flexibility and Understanding**
  - Allow users to decide inclusion in aggregations and visualizations.
  - Null values default to exclusion in BI tool graphs.

- **Benefits of Descriptive Values**
  - Provide more options for end users.
  - Enhance comprehensibility of data in dimensions.

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  - More understable for business users
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IMPLEMENTATION STRATEGY

- **Dimensional Null Attributes**
  - Replace nulls with dummy or descriptive values.
  - Maintain consistency and clarity across reporting and analysis.

- **Integration with Fact Tables**
  - If nulls originate from fact tables, ensure consistency in handling across dimensions.
  - Utilize consistent approaches for maintaining data integrity.

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- Replace nulls With descriptive values
  - More understable for business users
  - Values appear in aggregations in BI tools

HIERACHIE IN DIMENSIONS
INTRODUCTION TO DIMENSION HIERARCHIES

- **Purpose and Importance**
  - Dimensions often include hierarchies that organize data logically.
  - Understanding how to manage hierarchies effectively is crucial.
- **Source Data Normalization**
- **Transactional Data Nature**
  - Source data is typically normalized for transactional processing.
  - Example: Product and category stored in separate tables for efficiency.

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Customer_id	Customer name	Order id	Order_line_r	Product_FK	Category_FK
312	Franklin Miller	2314	Sunglases S	34	2

Snowflaked schema (should be avoided)

HIERARCHIE IN DIMENSIONS
CHALLENGES IN ANALYTICAL PROCESSING

- **Requirements for Data Warehouse**
  - Analytical processing requires high performance and usability.
  - Denormalization of data enhances read performance and usability.

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Customer_id	Customer name	Order id	Order_line_r	Product_FK	Category_FK
312	Franklin Miller	2314	Sunglases S	34	2

Snowflaked schema (should be avoided)

HIERARCHIE IN DIMENSIONS
PITFALLS OF SNOWFLAKING

- **Snowflaked Schema**
  - Over-normalization leads to a snowflaked schema.
  - Example: Product name linked to category via separate tables, creating multiple foreign keys.
  - Result: Complicated schema structure resembling a snowflake.
- **Issues with Snowflaking**
  - **Performance Impact**
    - Increases complexity and widens fact tables unnecessarily.
    - Decreases query performance due to multiple joins.
  - **Usability Concerns**
    - Reduced usability with complex schema
    - Difficulties in data retrieval and interpretation.

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Customer_id	Customer name	Order id	Order_line_r	Product_FK	Category_FK
312	Franklin Miller	2314	Sunglases S	34	2

Snowflaked schema (should be avoided)

HIERARCHIE IN DIMENSIONS
BEST PRACTICES FOR HIERARCHIES

- **Avoid Snowflaking**
  - Minimize unnecessary normalization in dimensions.
  - Keep hierarchies straightforward and intuitive.
- **Optimize for Performance and Usability**
  - Denormalize dimensions when beneficial for analytical queries.
  - Maintain a balance between normalization and denormalization based on performance needs.

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Customer_id	Customer name	Order id	Order_line_r	Product_FK	Category_FK
312	Franklin Miller	2314	Sunglases S	34	2

Snowflaked schema (should be avoided)

HIERARCHIE IN DIMENSIONS
CONCLUSION

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Conclusion

- **Balancing Act**
    - Strive for a well-structured schema that balances normalization with usability.
    - Enhance data warehouse performance and usability by optimizing dimension hierarchies effectively.

Customer_id	Customer name	Order id	Order_line_r	Product_FK	Category_FK
312	Franklin Miller	2314	Sunglases S	34	2

Snowflaked schema (should be avoided)

HIERARCHIE IN DIMENSIONS

DEALING WITH DATA NORMALIZATION IN DIMENSIONS

Normative Practices in Data Modeling

- **Normalization Habits**
  - Experienced data modelers often prioritize normalization.
  - Normalize data even if it's denormalized in the source for certain scenarios.

Challenges in Data Warehousing

- **Data Warehouse Requirements**
  - Unlike operational databases, data warehouses prioritize usability and performance.
  - Normalization can hinder these goals in analytical environments.
- **Resistance to Normalization in Data Warehouses**
- **Usability Concerns**
  - Normalization can complicate schema and reduce usability.
  - Avoid normalization to enhance data warehouse usability.

Often normalized

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

- Some professional ave the habit to normalize data
- Bad for usability & performance!
- We should not do that!

HIERARCHIE IN DIMENSIONS
DEALING WITH DATA NORMALIZATION IN DIMENSIONS

- **Embracing Denormalization**
- **Strategy for Dimensions**
  - Flatten or denormalize data in dimensions for better performance.
  - Example: Create a single table with joined attributes like Category_id and category name.
- **Benefits of Denormalization**
- **Enhanced Performance**
  - Simplifies querying and improves query performance.
  - Reduces complexity in schema design.
- **Conclusion**
- **Adopting Best Practices**
  - Prioritize denormalization over normalization in data warehouse dimensions.
  - Optimize schema for usability and query performance to support analytical needs effectively.

Flattened dimension

Product name	Category_id
Milk	1
Printer	2
Red Towel	3
Green Towel	3
Blue Towel	3

Category_id	Category
1	Groceries
2	Electronics
3	Houshold

Product_ID	Product name	Category
1	Milk	Groceries
2	Printer	Electronics
3	Red Towel	Houshold
4	Green Towel	Houshold
5	Blue Towel	Houshold

Flattened dimension

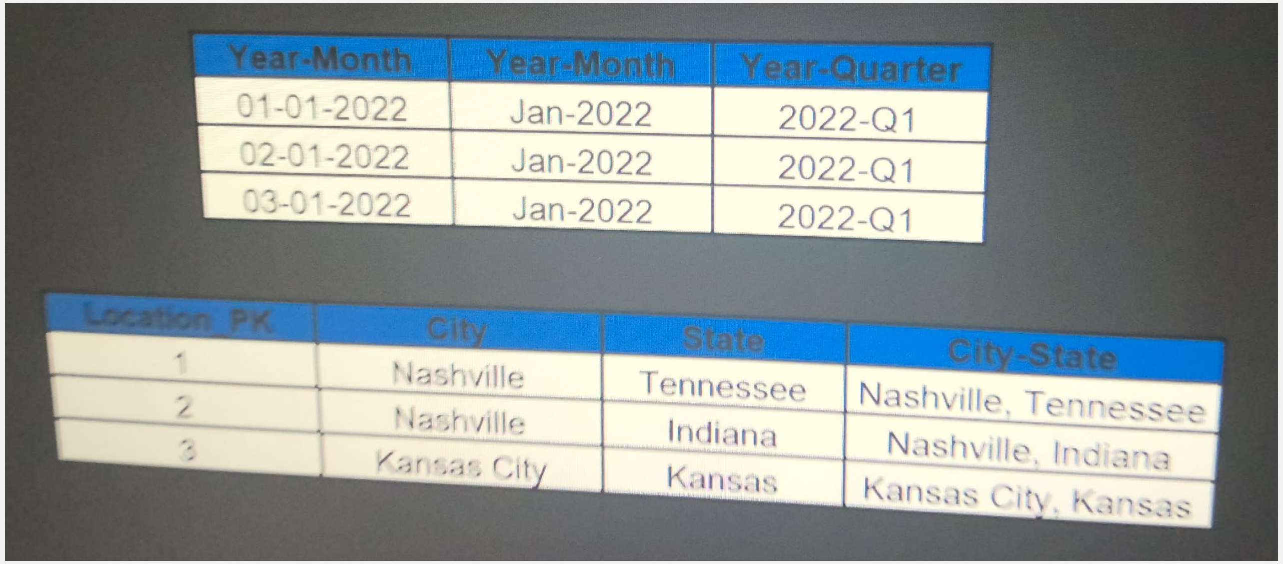
MANAGING HIERARCHIES IN DIMENSIONS

Combining Attributes Across Hierarchies

- **User-Friendly Approach**
  - Combine attributes from different hierarchy levels into a single column.
  - Example: Year and quarter combined for direct usability.

Handling Duplicate Values

- **Example: City Names**
  - Cities like Nashville may exist in multiple states.
  - Create pre-calculated columns (e.g., City_State) for clarity and usability.



Year-Month	Year-Month	Year-Quarter
01-01-2022	Jan-2022	2022-Q1
02-01-2022	Jan-2022	2022-Q1
03-01-2022	Jan-2022	2022-Q1

Location_PK	City	State	City-State
1	Nashville	Tennessee	Nashville, Tennessee
2	Nashville	Indiana	Nashville, Indiana
3	Kansas City	Kansas	Kansas City, Kansas

MANAGING HIERARCHIES IN DIMENSIONS CONCLUSION

- **Enhancing User Friendliness**
- **Simplifying Complex Hierarchies**
  - Simplify user experience by pre-combining commonly used attribute combinations.
  - Improve usability and accessibility of data.
- **Practical Considerations**
- **Reducing Dimension Complexity**
  - Collapse hierarchies into fewer tables for easier management.
  - Optimize dimension structure for enhanced query performance and usability.
- **Optimizing Dimension Design**
  - Focus on combining hierarchies effectively to streamline data access.
  - Prioritize user friendliness and performance in dimension management strategies.