Advanced Data Management Technologies

Unit 7 — Changing Dimensions

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Outline

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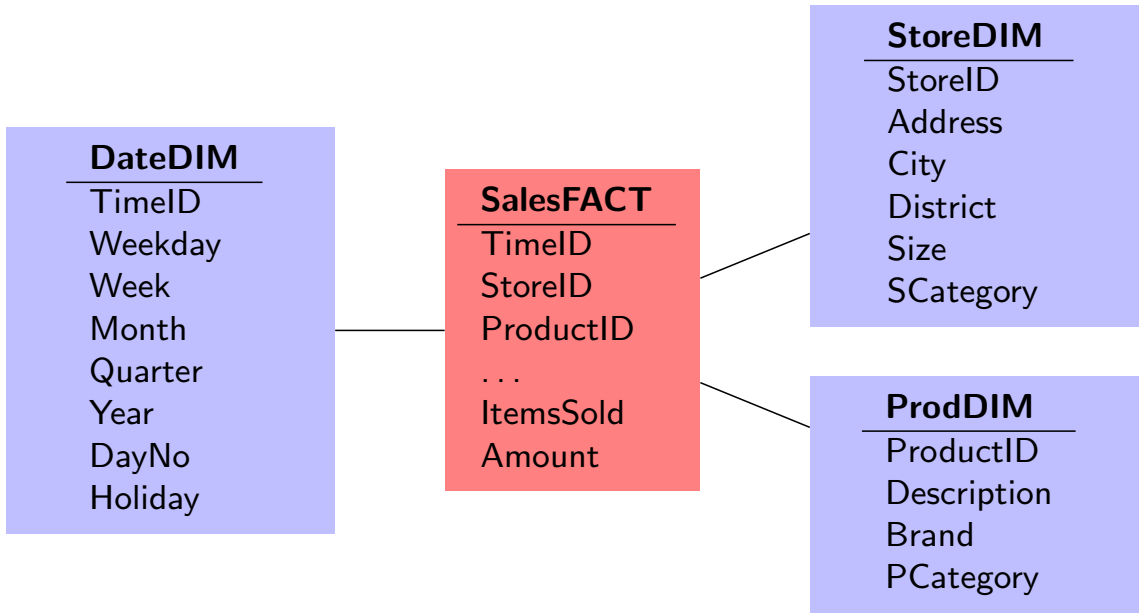
Changing Dimensions

- So far, we have implicitly assumed that dimensions are stable over time.
  - At most, new rows in dimension tables are inserted.
  - The existing rows do not change.
- This assumption is not valid in practice.
  - The phenomenon is called slowly changing dimensions.
  - The intuition is that dimension information changes, but changes are (relatively) rare.
- We will look at a number of techniques for handling changes in dimensions.
- Schema changes are not considered.
  - Then it becomes really funny!

Changing Dimensions/2



- Descriptions of stores and products vary over time.
  - A store is enlarged and changes Size.
  - A product changes Description.
  - Districts are changed.
- Problems
  - If we update the dimensions, wrong information will result.
  - If we don't update the dimensions, the DW is not up-to-date.

Solution 1: Overwrite Old Values/1

- **Solution 1:** Overwrite the old values that change in the dimension tables.
  - Today-for-yesterday viewpoint (up-to-date): all the events including past ones are always interpreted from the viewpoint of the current dimension values, without tracking previous instances.
  - Old facts point to rows in the dimension tables with incorrect information.
  - New facts (i.e., inserted after the dimension rows changed) point to rows with correct information.
- Pros
  - Easy to implement
  - Ideal if the changes are due to erroneous registrations.
  - In some cases, the imprecision can be disregarded.
- Cons
  - The solution does not solve the problem of capturing change.

Solutions 1: Overwrite Old Values/2

SalesFACT

StoreID	**...**	**ItemsSold**	**...**
001		2000	

StoreDIM

StoreID	**...**	**Size**	**City**
001		250	Chikago

SalesFACT

StoreID	**...**	**ItemsSold**	**...**
001		2000	

StoreDIM

StoreID	**...**	**Size**	**City**
001		450	Chicago

SalesFACT

StoreID	**...**	**ItemsSold**	**...**
001		2000	
001		2500	

StoreDIM

StoreID	**...**	**Size**	**City**
001		450	Chicago

Solution 2: Versioning of Rows/1

- **Solution 2:** Versioning of rows with changing attributes.
  - An event stored into a fact table is associated with the version of the dimesion row that was valid when that event took place.
  - Today-or-yesterday viewpoint (historical truth): Each event is analyzed according to the dimension values at the time when the event occurred.
  - Yields larger dimension tables
- Pros
  - Correct information captured in DW
  - No problems when formulating queries
- Cons
  - It is not possible to capture the development over time of the subjects the dimensions describe since time of change is not recorded.

Solution 2: Versioning of Rows/2

SalesFACT

StoreID	...	**ItemsSold**	...
001		2000	

StoreDIM

StoreID	...	**Size**	...
001		250	

SalesFACT

StoreID	...	**ItemsSold**	...
001		2000	

StoreDIM

StoreID	...	**Size**	...
001		250	
002		450	

SalesFACT

StoreID	...	**ItemsSold**	...
001		2000	
002		2500	

StoreDIM

StoreID	...	**Size**	...
001		250	
002		450	

Solution 3: Timestamping of Rows/1

- **Solution 3:** Versioning of rows with changing attributes like in Solution 2 + timestamping of rows to support every temporal analysis scenario.
- Additionally yesterday-for-today viewpoint (rollback) is supported: after the user has set a specific date, the dimension table rows that were valid at that time are found.
- Add a new tuple to the dimension table whenever an attribute changes.
- Required features:
  - A couple of timestamps specifying the validity interval of tuples
  - A master attribute that specifies the key value of the tuple from which each tuple stems
- Pros
  - Correct information captured in DW as time is stored
- Cons
  - Larger dimension tables

Solution 3: Timestamping of Rows/2

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	

StoreDIM

StoreID	Size	From	To	Master
001	250	98	-	1
002	400	98	-	2

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	

StoreDIM

StoreID	Size	From	To	Master
001	250	98	99	1
002	400	98	-	2
003	450	00	-	1

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	
002	456		2500	

StoreDIM

StoreID	Size	From	To	Master
001	250	98	99	1
002	400	98	-	2
003	450	00	-	1

Solution 3: Timestamping of Rows/3

- Product descriptions are versioned, when products are changed, e.g., new package sizes.
- New facts can refer to both the newest and older versions of products, as old versions are still in the stores.
- Thus, the Time value for a fact should not necessarily be between the From and To values in the Product dimension row.
- This is unlike changes in Size for a store, where all facts from a certain point in time will refer to the newest Size value.
- This is also unlike alternative categorizations (e.g, department) that one wants to choose between.

Solution 3b: Special Facts/1

- **Solution 3b:** Solution 2 + special facts for capturing changes in dimensions via the Time dimension.
  - When a change occurs and there is no simultaneous, new fact referring to the new dimension row, a new special fact is created that points to the new dimension row and thus timestamps the row via the fact row's reference to the Time dimensions.
- Pros
  - It is possible to capture the development over time of the subjects that the dimensions describe
  - Smaller dimension tables than in solution 3a
- Cons
  - Complexity of working with this solution

Solution 3b: Special Facts/2

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	

StoreDIM

StoreID	...	Size	...
001		250	

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	
002	345		-	

StoreDIM

StoreID	...	Size	...
001		250	
002		450	

SalesFACT

StoreID	TimeID	...	ItemsSold	...
001	234		2000	
002	345		-	
002	456		250	

StoreDIM

StoreID	...	Size	...
001		250	
002		450	

Outline

Rapidly Changing Dimensions/1

- Difference between slowly and rapidly is subjective.
- Solution 2 is often still feasible
- A problem might be the size of the dimension
  - e.g., an Employee dimension with 100,000 employees, each using 2K and many changes every year.
- Other typical examples of (large) dimensions with many changes are Product and Customer.
  - Some Customer dimensions can have 10M customers.
  - Use Solution 2 and suitable indexing!
- Monster dimensions: The more attributes in a dimension table, the more changes per row can be expected $\Rightarrow$ dimension might become very large.
  - e.g., a Customer dimension with 100M customers and many attributes.

Rapidly Changing Dimensions/2

- Solution with Mini-dimension
  - Make a mini-dimension with the often-changing attributes, e.g., demographic attributes.
  - Convert (numeric) attributes with many possible values into attributes with few possible values, representing groups of the original values.
  - Insert rows for all combinations of values from these new domains.
    - With 6 attributes with 10 possible values each, the dimension gets 1,000,000 rows.
    - Alternatively, (combination) rows can be inserted when needed.
  - If the mini-dimension is too large, it can be split into two or more mini-dimensions.

Rapidly Changing Dimensions/3

CustID
Name
PostalAddress
Gender
DateofBirth
Customerside
...
NoKids
MaritialStatus
CreditScore
BuyingStatus
Income
Education
...

CustID
Name
PostalAddress
Gender
DateofBirth
Customerside
...

DemographyID
NoKids
MaritialStatus
CreditScoreGroup
BuyingStatusGroup
IncomeGroup
EducationGroup
...

Rapidly Changing Dimensions/5

- Pros
  - DW size (dimension tables) is kept down.
  - Changes in a customer's demographic values do not result in changes in the customer dimension.
    - Rows must be inserted only into the mini-dimension.
- Cons
  - More dimensions and more keys in the star schema.
  - Using value groups gives less detail.
  - The construction of groups is irreversible and makes it hard to make other groupings.
  - Navigation of customer attributes is more cumbersome as these are in more than one dimension.
    - An ActualDemography attribute can be added to the dimension with the stable values.

Summary

- Multidimensional models realized as star schemas support change over time to a large extent.
- This is important!
  - Applications change.
  - The modeled reality changes.
- Three techniques for handling changing dimensions.
  - Overwrite old values: simplest, but captures only up-to-date view
  - Versioning of rows: very often a good tradeoff, captures historical truth
  - Timestamping of rows: most advanced solution, support rollback.
- Rapidly changing dimensions and monster dimensions might occur, which might lead to very large dimensions
- Mini-dimensions is a solution to solve the size problem.