IBM Cognos Framework Manager
Version 10.1.1

Guidelines for Modeling Metadata

Note
Before using this information and the product it supports, read the information in "Notices" on page 53.

Product Information

This document applies to IBM Cognos Business Intelligence Version 10.1.1 and may also apply to subsequent releases. To check for newer versions of this document, visit the IBM Cognos Information Centers (http://publib.boulder.ibm.com/infocenter/cogic/v1r0m0/index.jsp).

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Introduction

IBM® Cognos® Framework Manager is a metadata modeling tool. A model is a business presentation of the information in one or more data sources. When you add security and multilingual capabilities to this business presentation, one model can serve the needs of many groups of users around the globe.

The document discusses fundamental IBM Cognos modeling concepts that you need to understand about modeling metadata for use in business reporting and analysis. It also discusses building the relational model.

Audience

This document is intended to help you understand IBM Cognos modeling concepts.

Finding information

To find IBM Cognos product documentation on the web, including all translated documentation, access one of the IBM Cognos Information Centers. Release Notes are published directly to Information Centers, and include links to the latest technotes and APARs.

You can also read PDF versions of the product release notes and installation guides directly from IBM Cognos product disks.

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Framework Manager has accessibility features. For information on these features, see the accessibility section in the Framework Manager *User Guide*.

Chapter 1. Guidelines for Modeling Metadata

IBM Cognos Framework Manager is a metadata modeling tool that drives query generation for IBM Cognos BI. A model is a collection of metadata that includes physical information and business information for one or more data sources. IBM Cognos BI enables performance management on normalized and denormalized relational data sources as well as a variety of OLAP data sources.

To access the IBM Cognos *Guidelines for Modeling Metadata* documentation in a different language, go to *installation_location*\c10\webcontent\documentation and open the folder for the language you want. Then open ug_best.pdf.

Understanding IBM Cognos Modeling Concepts

Before you begin, you need to understand fundamental IBM Cognos modeling concepts about modeling metadata for use in business reporting and analysis.

Relational Modeling Concepts

When modeling in IBM Cognos Framework Manager, it is important to understand that there is no requirement to design your data source to be a perfect star schema. Snowflaked and other forms of normalized schemas are equally acceptable as long as your data source is optimized to deliver the performance you require for your application. In general, we recommend that you create a logical model that conforms to star schema concepts. This is a requirement for IBM Cognos Analysis Studio and has also proved to be an effective way to organize data for your users.

When beginning to develop your application with a complex data source, it is recommended that you create a simplified view that represents how your users view the business and that is designed using the guidelines in this document to deliver predictable queries and results. A well-built relational model acts as the foundation of your application and provides you with a solid starting point if you choose to take advantage of dimensional capabilities in IBM Cognos software.

If you are starting with a star schema data source, less effort is required to model because the concepts employed in creating a star schema lend themselves well to building applications for query and analysis. The guidelines in this document will assist you in designing a model that will meet the needs of your application.

Cardinality

Relationships exist between two query subjects. The cardinality of a relationship is the number of related rows for each of the two query subjects. The rows are related by the expression of the relationship; this expression usually refers to the primary and foreign keys of the underlying tables.

IBM Cognos software uses the cardinality of a relationship in the following ways:

- to avoid double-counting fact data
- to support loop joins that are common in star schema models
- to optimize access to the underlying data source system
- to identify query subjects that behave as facts or dimensions

A query that uses multiple facts from different underlying tables is split into separate queries for each underlying fact table. Each single fact query refers to its respective fact table as well as to the dimensional tables related to that fact table. Another query is used to merge these individual queries into one result set. This latter operation is generally referred to as a stitched query. You know that you have a stitched query when you see `coalesce` and a full outer join.

A stitched query also allows IBM Cognos software to properly relate data at different levels of granularity. See "Multiple-fact, Multiple-grain Queries" on page 8.

Cardinality in Generated Queries:

IBM Cognos software supports both minimum-maximum cardinality and optional cardinality.

In `0:1`, `0` is the minimum cardinality, `1` is the maximum cardinality.

In `1:n`, `1` is the minimum cardinality, `n` is the maximum cardinality.

A relationship with cardinality specified as `1:1` to `1:n` is commonly referred to as `1` to `n` when focusing on the maximum cardinalities.

A minimum cardinality of `0` indicates that the relationship is optional. You specify a minimum cardinality of `0` if you want the query to retain the information on the other side of the relationship in the absence of a match. For example, a relationship between customer and actual sales may be specified as `1:1` to `0:n`. This indicates that reports will show the requested customer information even though there may not be any sales data present.

Therefore a `1` to `n` relationship can also be specified as:

- `0:1` to `0:n`
- `0:1` to `1:n`
- `1:1` to `0:n`
- `1:1` to `1:n`

Use the **Relationship impact** statement in the **Relationship Definition** dialog box to help you understand cardinality. For example, Sales Staff (`1:1`) is joined to Orders (`0:n`).

It is important to ensure that the cardinality is correctly captured in the model because it determines the detection of fact query subjects and it is used to avoid double-counting factual data.

When generating queries, IBM Cognos software follows these basic rules to apply cardinality:

- Cardinality is applied in the context of a query.
- `1` to `n` cardinality implies fact data on the `n` side and implies dimension data on the `1` side.

- A query subject may behave as a fact query subject or as a dimensional query subject, depending on the relationships that are required to answer a particular query.

Use the **Model Advisor** to see an assessment of the behavior implied by cardinality in your model.

For more information, see "Single Fact Query" on page 37 and "Multiple-fact, Multiple-grain Query on Conformed Dimensions" on page 39.

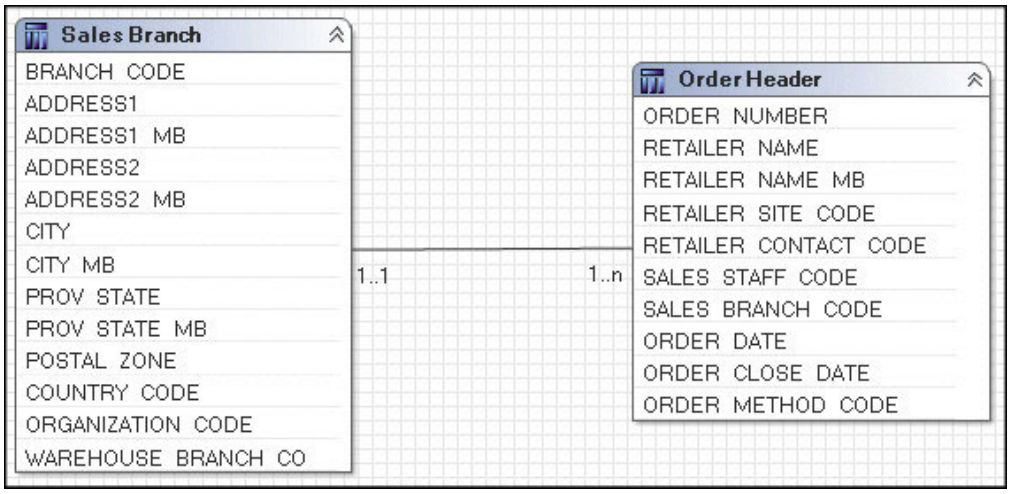
Cardinality in the Context of a Query:

The role of cardinality in the context of a query is important because cardinality is used to determine when and where to split the query when generating multiple-fact queries. If dimensions and facts are incorrectly identified, stitched queries can be created unnecessarily, which is costly to performance, or the queries can be incorrectly formed, which can give incorrect results.

The following examples show how cardinality is interpreted by IBM Cognos software.

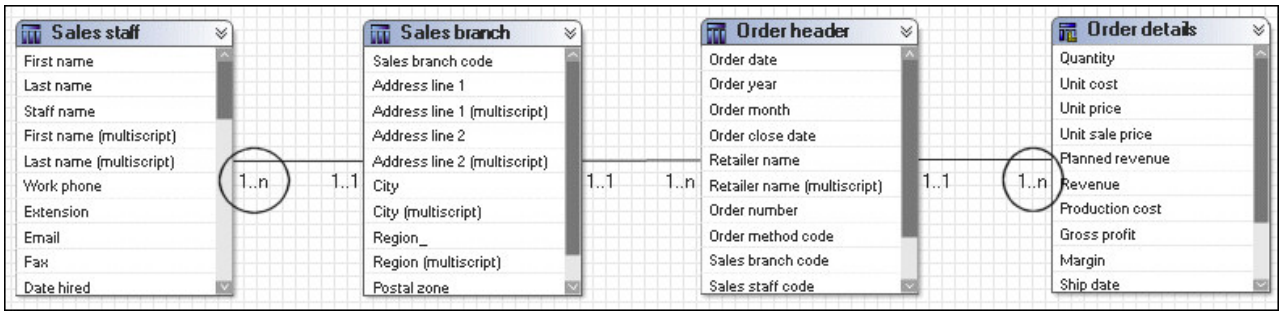
Example: Query Subjects Behaving as a Dimension and a Fact:

In this example, Sales Branch behaves as a dimension relative to Order Header and Order Header behaves as a fact relative to Sales Branch.



Example: Four Query Subjects Included in a Query:

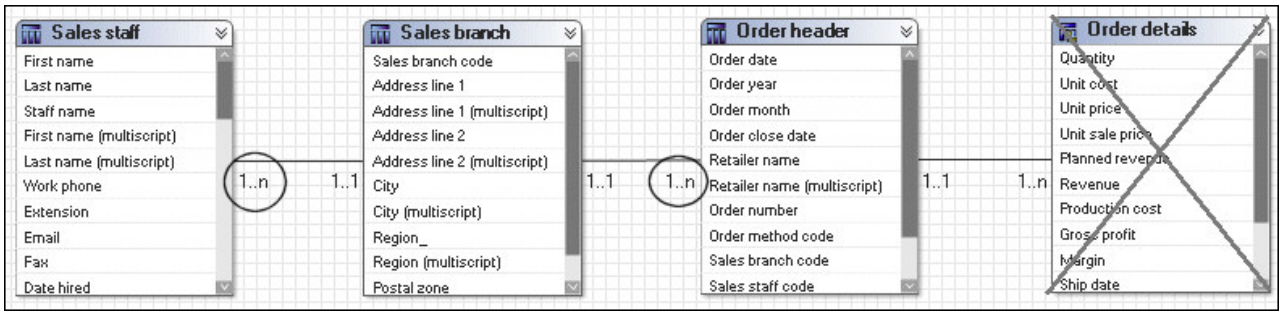
In this example, all four query subjects are included in a query. Sales staff and Order details are treated as facts. Order header and Sales branch are treated as dimensions.



The SQL generated for this query will be split, treating Sales staff and Order details as facts. The results of these two subqueries are stitched using the information retrieved from Sales branch. This gives a report that lists the Sales staff information by Sales branch next to the Order details and Order header information by Sales branch.

Example: Three Query Subjects Included in a Query:

In this example, only three query subjects are included in a query. Order details is not used. Order header is now treated as a fact. Sales staff continues to be treated as a fact.



The SQL in this example also generates a stitched query, which returns a similar result as above. Note that a stitch operation retains the information from both sides of the operation by using a full outer join.

Determinants

Determinants reflect granularity by representing subsets or groups of data in a query subject and are used to ensure correct aggregation of this repeated data. Determinants are most closely related to the concept of keys and indexes in the data source and are imported based on unique key and index information in the data source. We recommend that you always review the determinants that are imported and, if necessary, modify them or create additional ones. By modifying determinants, you can override the index and key information in your data source, replacing it with information that is better aligned with your reporting and analysis needs. By adding determinants, you can represent groups of repeated data that are relevant for your application.

An example of a unique determinant is Day in the Time example below. An example of a non-unique determinant is Month; the key in Month is repeated for the number of days in a particular month. When you define a non-unique

determinant, you should specify **Group By**. This indicates to IBM Cognos software that when the keys or attributes associated with that determinant are repeated in the data, it should apply aggregate functions and grouping to avoid double-counting. It is not recommended that you specify determinants that have both **Uniquely Identified** and **Group By** selected or have neither selected.

Year Key	Month Key	Month Name	Day Key	Day Name
2006	200601	January 06	20060101	Sunday, January 1, 2006
2006	200601	January 06	20060102	Monday, January 2, 2006

You can define three determinants for this data set as follows -- two **Group By** determinants (Year and Month) and one unique determinant (Day). The concept is similar but not identical to the concept of levels and hierarchies.

Name of the Determinant	Key	Attributes	Uniquely Identified	Group By
Year	Year Key	None	No	Yes
Month	Month Key	Month Name	No	Yes
Day	Day Key	Day Name Month Key Month Name Year Key	Yes	No

In this case, we use only one key for each determinant because each key contains enough information to identify a group within the data. Often Month is a challenge if the key does not contain enough information to clarify which year the month belongs to. In this case, however, the Month key includes the Year key and so, by itself, is enough to identify months as a sub-grouping of years.

Note: While you can create a determinant that groups months without the context of years, this is a less common choice for reporting because all data for February of all years would be grouped together instead of all data for February 2006 being grouped together.

Using Determinants with Multiple-Part Keys

In the Time dimension example above, one key was sufficient to identify each set of data for a determinant but that is not always the case.

For example, the following Geography dimension uses multiple-part key definitions for all but one determinant.

Region	Region Key	State/Province Key	City Key
North America	USA	Illinois	Springfield
North America	USA	Missouri	Springfield
North America	USA	California	Dublin
Europe	Ireland	n/a	Dublin

Similar to the example about Time, you can define three determinants for this data set as follows -- two **Group By** determinants (Region and State/Province) and one unique determinant (City).

Name of the Determinant	Key	Attributes	Uniquely Identified	Group By
Region	Region Key	None	No	Yes
State/Province	State/Province Key	None	No	Yes
City	Region Key State/Province Key City Key	None	Yes	No

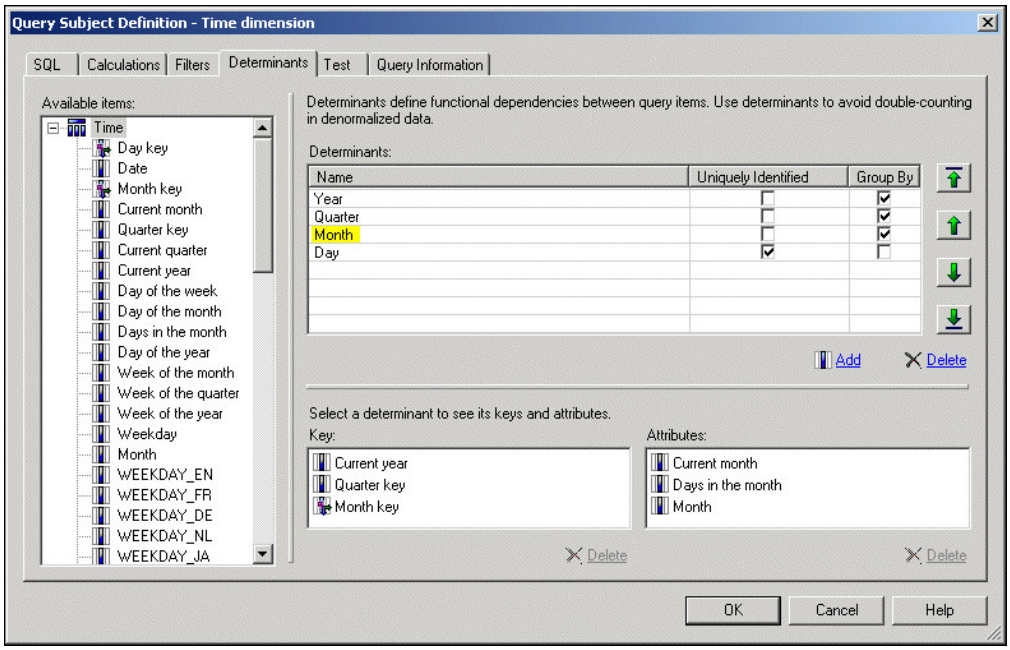
In this case, we used Region Key, State/Province Key, and City Key to ensure uniqueness for City. We did this because in the data we were given, some city names were repeated across states or provinces, which in turn were repeated for regions.

Determinants Are Evaluated in the Order In Which They Are Specified

There is no concept of a hierarchy in determinants, but there is an order of evaluation. When IBM Cognos software looks at a selection of items from a query subject, it compares them to each determinant (keys and attributes) one at a time in the order that is set in the **Determinants** tab. In this way, IBM Cognos software selects the determinant that is the best match.

In the following example, the attributes current month, days in month, and localized month names are associated to the Month key. When a query is submitted that references any one of these attributes, the Month determinant is the first determinant on which the matching criteria is satisfied. If no other attributes are required, the evaluation of determinants stops at Month and this determinant is used for the `group` and `for` clauses in the SQL.

In cases where other attributes of the dimension are also included, if those attributes have not been matched to a previous determinant, IBM Cognos software continues evaluating until it finds a match or reaches the last determinant. It is for this reason that a unique determinant has all query items associated to it. If no other match is found, the unique key of the entire data set is used to determine how the data is grouped.



When to Use Determinants

While determinants can be used to solve a variety of problems related to data granularity, you should always use them in the following primary cases:

- A query subject that behaves as a dimension has multiple levels of granularity and will be joined on different sets of keys to fact data.

  For example, Time has multiple levels, and it is joined to Inventory on the Month Key and to Sales on the Day Key. For more information, see "Multiple-fact, Multiple-grain Queries" on page 8.
- There is a need to count or perform other aggregate functions on a key or attribute that is repeated.

  For example, Time has a Month Key and an attribute, Days in the month, that is repeated for each day. If you want to use Days in the month in a report, you do not want the sum of Days in the month for each day in the month. Instead, you want the unique value of Days in the month for the chosen Month Key. In SQL, that is `XMIN(Days in the month for Month_Key)`. There is also a `Group by` clause in the Cognos SQL.

There are less common cases when you need to use determinants:

- You want to uniquely identify the row of data when retrieving text BLOB data from the data source.

  Querying blobs requires additional key or index type information. If this information is not present in the data source, you can add it using determinants. Override the determinants imported from the data source that conflict with relationships created for reporting.

  You cannot use multiple-segment keys when the query subject accesses blob data. With summary queries, blob data must be retrieved separately from the summary portion of the query. To do this, you need a key that uniquely identifies the row and the key must not have multiple segments.
- A join is specified that uses fewer keys than a unique determinant that is specified for a query subject.

If your join is built on a subset of the columns that are referenced by the keys of a unique determinant on the 0..1 or 1..1 side of the relationships, there will be a conflict. Resolve this conflict by modifying the relationship to fully agree with the determinant or by modifying the determinant to support the relationship.

- You want to override the determinants imported from the data source that conflict with relationships created for reporting.

  For example, there are determinants on two query subjects for multiple columns but the relationship between the query subjects uses only a subset of these columns. Modify the determinant information of the query subject if it is not appropriate to use the additional columns in the relationship.

Multiple-fact, Multiple-grain Queries

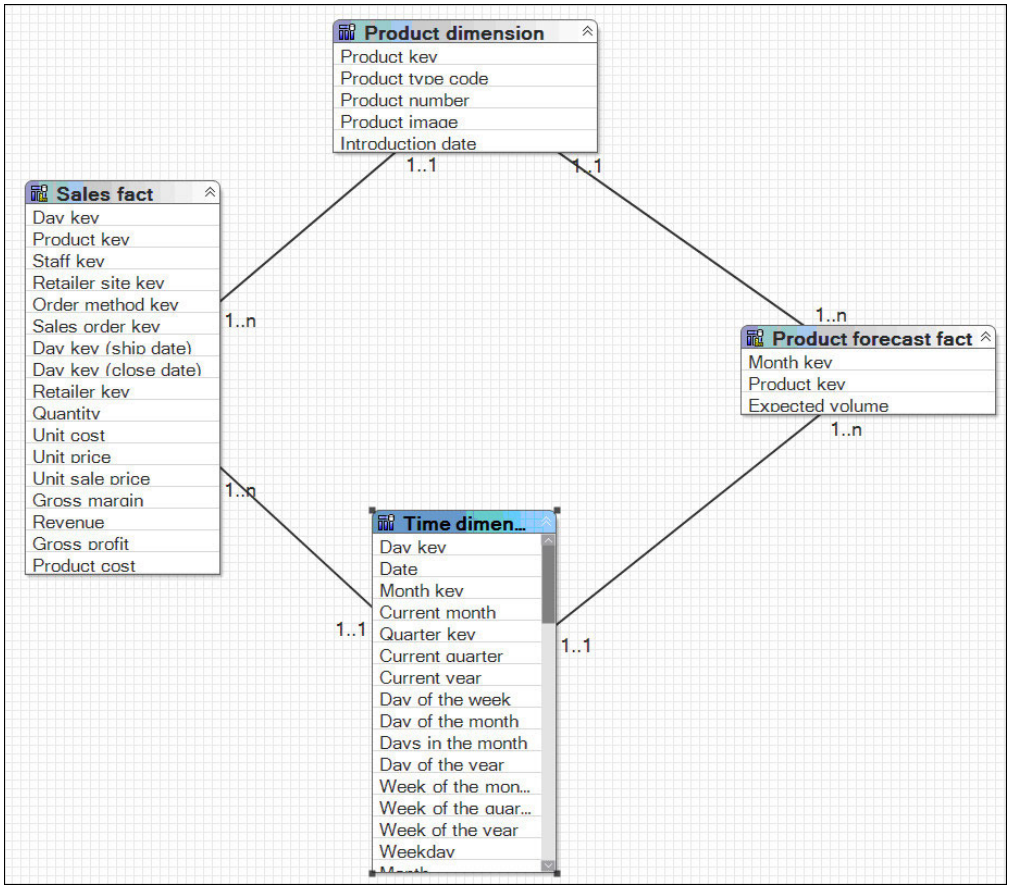
Multiple-fact, multiple-grain queries in relational data sources occur when a table containing dimensional data is joined to multiple fact tables on different key columns.

Note that in this section, the term dimension is used in the conceptual sense. A query subject with cardinality of 1:1 or 0:1 behaves as a dimension. For more information, see "Cardinality" on page 1.

A dimensional query subject typically has distinct groups, or levels, of attribute data with keys that repeat. The IBM Cognos studios automatically aggregate to the lowest common level of granularity present in the report. The potential for double-counting arises when creating totals on columns that contain repeated data. When the level of granularity of the data is modeled correctly, double-counting can be avoided.

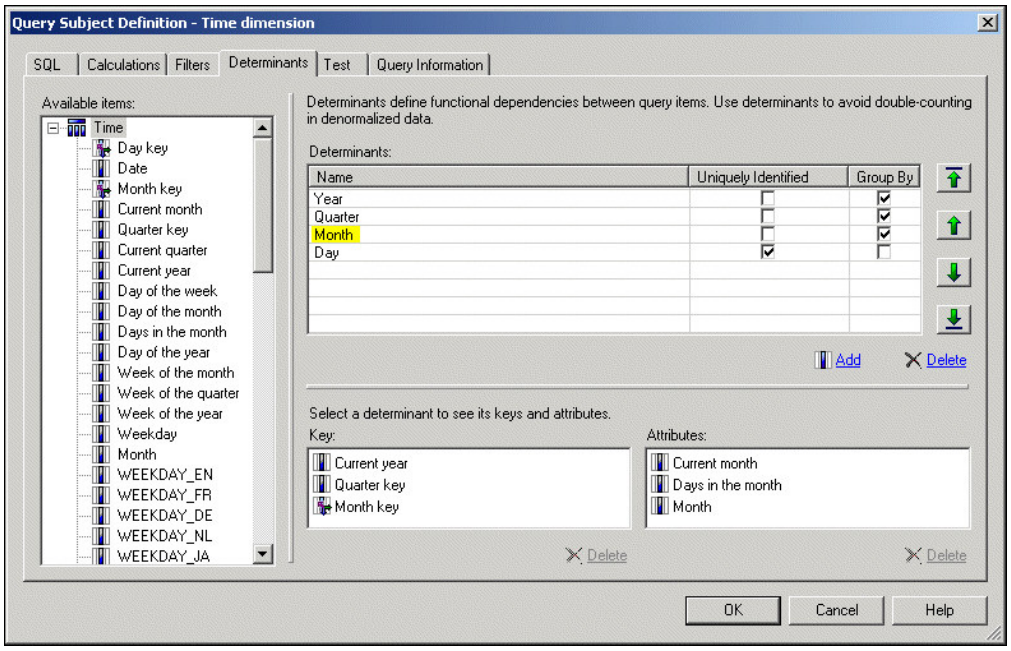
Note: You can report data at a level of granularity below the lowest common level. This causes the data of higher granularity to repeat, but the totals will not be affected if determinants are correctly applied.

This example shows two fact query subjects, Sales and Product forecast, that share two dimensional query subjects, Time and Product.



Time is the focal point of the granularity issue in this example. Sales is joined to Time on the Day key, and Product forecast is joined to Time on the Month key. Because of the different join keys, a minimum of two determinants must be clearly identified on Time. For example, the determinants for Month and Day have their keys identified. Day is the unique key for Time, Month keys are repeated for each day in the month.

For example, the determinant for Month is as follows.



The Product query subject could have at least three determinants: Product line, Product type, and Product. It has relationships to both fact tables on the Product key. There are no granularity issues with respect to the Product query subject.

By default, a report is aggregated to retrieve records from each fact table at the lowest common level of granularity. If you create a report that uses Quantity from Sales, Expected volume from Product forecast, Month from Time, and Product name from Product, the report retrieves records from each fact table at the lowest common level of granularity. In this example, it is at the month and product level.

To prevent double-counting when data exists at multiple levels of granularity, create at least two determinants for the Time query subject. For an example, see "Determinants" on page 4.

Month	Product name	Quantity	Expected volume
April 2007	Aloe Relief	1,410	1,690
April 2007	Course Pro Umbrella	132	125
February 2007	Aloe Relief	270	245
February 2007	Course Pro Umbrella		1
February 2006	Aloe Relief	88	92

If you do not specify the determinants properly in the Time query subject, incorrect aggregation may occur. For example, Expected volume values that exist at the Month level in Product forecast is repeated for each day in the Time query subject. If determinants are not set correctly, the values for Expected volume are multiplied by the number of days in the month.

Month	Product name	Quantity	Expected volume
April 2007	Aloe Relief	1,410	50,700
April 2007	Course Pro Umbrella	132	3,750
February 2007	Aloe Relief	270	7,134

Month	Product name	Quantity	Expected volume
February 2007	Course Pro Umbrella		29
February 2006	Aloe Relief	88	2,576

Note the different numbers in the Expected volume column.

Model Design Considerations

When building a model, it is important to understand that there is no single workflow that will deliver a model suitable for all applications. Before beginning your model, it is important to understand the application requirements for functionality, ease of use, and performance. The design of the data source and application requirements will determine the answer to many of the questions posed in this section.

Where Should You Create Relationships and Determinants?

A frequently asked question is where to create relationships. Should relationships be created between data source query subjects, between model query subjects, or between both? The answer may vary because it depends on the complexity of the data source that you are modeling.

When working with data source query subjects, relationships and determinants belong together.

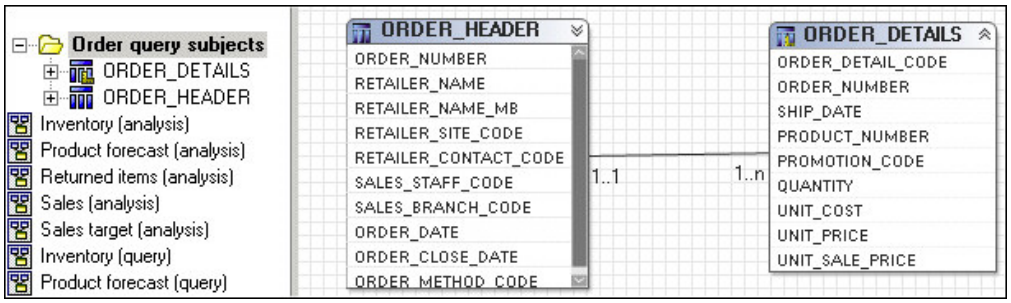
When working with model query subjects, there are side effects to using relationships and determinants that you should consider:

- The model query subject starts to function as a view, which overrides the **As View** or **Minimized** setting in the **SQL Generation** type for a query subject.

  This means that the SQL stays the same no matter which items in the query subject are referenced. For more information, see "What Is Minimized SQL?" on page 12.
- The model query subject becomes a stand-alone object.

  This means underlying relationships are no longer applied, except those between the objects that are referenced. It may be necessary to create additional relationships that were previously inferred from the metadata of the underlying query subjects.
- When a determinant is created on a model query subject, the determinant is ignored unless a relationship is also created.

Here is an example of a relationship on a model query subject that purposely overrides the **Minimized SQL** setting and simplifies the model. In this example, Order Header and Order Details are combined so that they behave as a single fact. They are placed in their own folder and all relationships to them are deleted except the relationship between Order Header and Order Details. This is the only relationship that will matter after a model query subject is created and relationships attached to it.



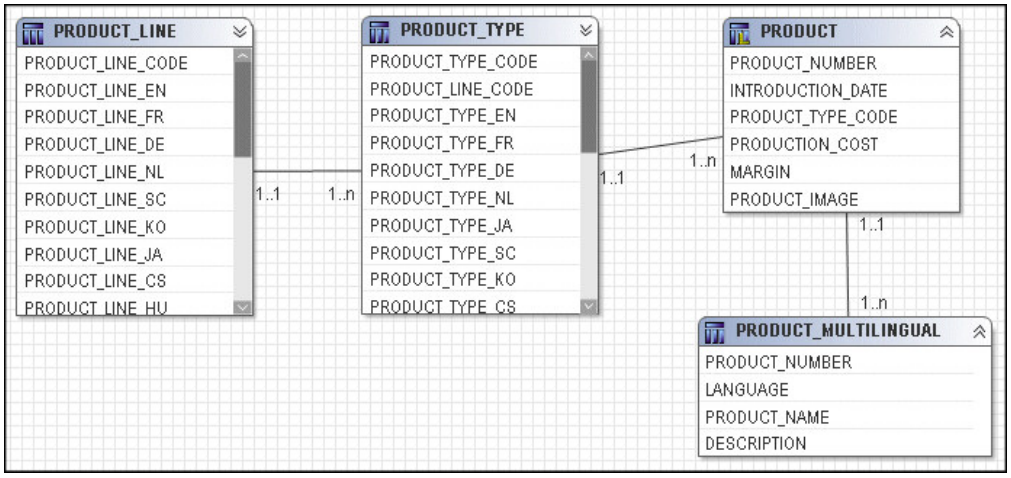
To decide where to specify relationships and determinants in the model, you must understand the impact of minimized SQL to your application.

For more information about relationships, determinants, and minimized SQL, see the **Model Advisor** topics in the IBM Cognos Framework Manager *User Guide*.

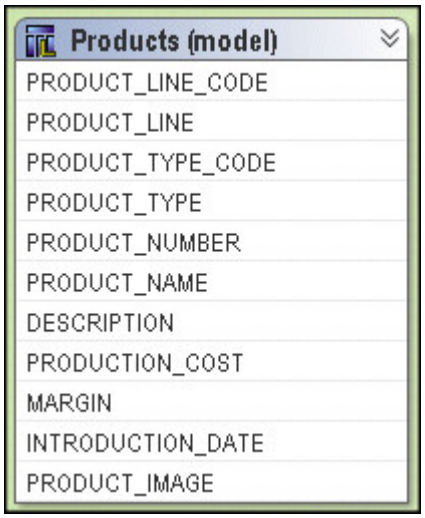
What Is Minimized SQL?

When you use minimized SQL, the generated SQL contains only the minimal set of tables and joins needed to obtain values for the selected query items.

To see an example of what minimized SQL means, you can use the following Product tables. Four query subjects, Product Line, Product Type, Product, and Product Multilingual all join to each other.



They can be combined in a model query subject.



If you test the Products model query subject as a whole, you see that four tables are referenced in the `from` clause of the query.

```
select
 PRODUCT_LINE.PRODUCT_LINE_CODE as Product_Line_Code,
 PRODUCT_LINE.PRODUCT_LINE_EN as Product_Line,
 PRODUCT_TYPE.PRODUCT_TYPE_CODE as Product_Type_Code,
 PRODUCT_TYPE.PRODUCT_TYPE_EN as Product_Type,
 PRODUCT.PRODUCT_NUMBER as Product_Number,
 PRODUCT_MULTILINGUAL.PRODUCT_NAME as Product_Name
 PRODUCT_MULTILINGUAL.DESCRIPTION as Product_Description,
 PRODUCT.INTRODUCTION_DATE as Introduction_Date,
 PRODUCT.PRODUCT_IMAGE as Product_Image,
 PRODUCT.PRODUCTION_COST as Production_Cost,
 PRODUCT.MARGIN as Margin
from
 gosl_82..gosl.PRODUCT_LINE PRODUCT_LINE,
 gosl_82..gosl.PRODUCT_TYPE PRODUCT_TYPE,
 gosl_82..gosl.PRODUCT PRODUCT,
 gosl_82..gosl.PRODUCT_MULTILINGUAL PRODUCT_MULTILINGUAL
where
 (PRODUCT_MULTILINGUAL."LANGUAGE" - N'EN')
 and
 (PRODUCT_LINE.PRODUCT_LINE_CODE = PRODUCT_TYPE.PRODUCT_LINE_CODE)
and
 (PRODUCT_TYPE.PRODUCT_TYPE_CODE = PRODUCT.PRODUCT_TYPE_CODE)
and
 (PRODUCT.PRODUCT_NUMBER = PRODUCT_MULTILINGUAL.PRODUCT_NUMBER
```

If you test only Product name, you see that the resulting query uses only Product Multilingual, which is the table that was required. This is the effect of minimized SQL.

```
select
 PRODUCT_MULTILINGUAL.PRODUCT_NAME as Product_Name
from
 gosl_82..gosl.PRODUCT_MULTILINGUAL PRODUCT_MULTILINGUAL
where
 (PRODUCT_MULTILINGUAL."LANGUAGE" - N'EN")
```

Example: When Minimized SQL Is Important

If you are modeling a normalized data source, you may be more concerned about minimized SQL because it will reduce the number of tables used in some requests

and perform better. In this case, it would be best to create relationships and determinants between the data source query subjects and then create model query subjects that do not have relationships.

There is a common misconception that if you do not have relationships between objects, you cannot create star schema groups. This is not the case. Select the model query subjects to include in the group and use the **Star Schema Grouping** wizard. Or you can create shortcuts and move them to a new namespace. There is no need to have shortcuts to the relationships; this feature is purely visual in the diagram. The effect on query generation and presentation in the studios is the same.

Example: When Minimized SQL Is Not as Important as Predictable Queries

There may be some elements in a data source that you need to encapsulate to ensure that they behave as if they were one data object. An example might be a security table that must always be joined to a fact. In the Great Outdoors Sales model, Order Header and Order Details are a set of tables that together represent a fact and you would always want them to be queried together. For an example, see "Where Should You Create Relationships and Determinants?" on page 11.

What Is Metadata Caching?

IBM Cognos Framework Manager stores the metadata that is imported from the data source. However depending on governor settings and certain actions you take in the model, this metadata might not be used when preparing a query.

If you enable the **Allow enhanced model portability at run time** governor, Framework Manager always queries the data source for information about the metadata before preparing a query. If you have not enabled this governor, in most cases Framework Manager accesses the metadata that has been stored in the model instead of querying the data source. The main exceptions are:

- The SQL in a data source query subject has been modified. This includes the use of macros.
- A calculation or filter has been added to a data source query subject.

Note: The generated metadata queries are well supported by most relational database management system vendors and should not have a noticeable impact on most reporting applications.

Query Subjects vs. Dimensions

Query subjects and dimensions serve separate purposes. The query subject is used to generate relational queries and may be created using star schema rules, while the dimension is used for dimensional modeling of relational sources, which introduces OLAP behavior. Because query subjects are the foundation of dimensions, a key success criterion for any dimensional model is a sound relational model.

A dimensional model is required only if you want to use IBM Cognos Analysis Studio, to enable drilling up and down in reports, or to access member functions in the studios. For many applications, there is no need for OLAP functionality. For example, your application is primarily for ad hoc query or reporting with no requirement for drilling up and down. Or you are maintaining an IBM Cognos ReportNet® model. In these cases, you may choose to publish packages based on query subjects alone.

Determinants for query subjects are not the same as levels and hierarchies for regular dimensions but they can be closely related to a single hierarchy. If you are planning to use your query subjects as the foundation for dimensions, you should consider the structure of the hierarchies you expect to create and ensure that you have created determinants that will support correct results when aggregating. Ensure that you have the following:

- The query subject should have a determinant specified for each level of the hierarchy in the regular dimension.
- The determinants should be specified in the same order as the levels in the regular dimension.
- If you expect to have multiple hierarchies that aggregate differently, you may need to consider creating an additional query subject with different determinants as the source for the other hierarchy.

By creating a complete relational model that delivers correct results and good performance, you will have a strong foundation for developing a dimensional model. In addition, by ensuring that a layer of model objects, either query subjects or dimensions, exists between the data source and the objects exposed to the studios, you are better able to shield your users from change.

Model Objects vs. Shortcuts

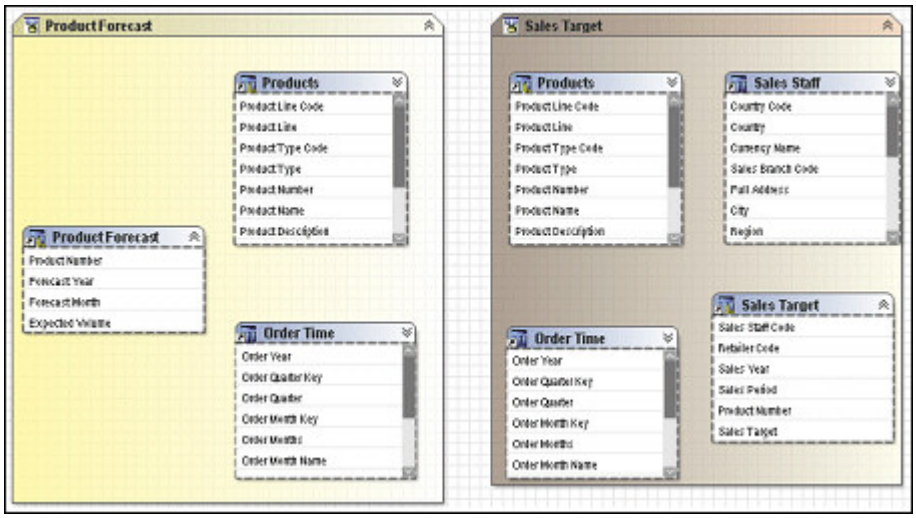
The key difference between model objects and shortcuts is that model objects give you the freedom to include or exclude items and to rename them. You may choose to use model objects instead of shortcuts if you need to limit the query items included or to change the names of items.

Shortcuts are less flexible from a presentation perspective than model objects, but they require much less maintenance because they are automatically updated when the target object is updated. If maintenance is a key concern and there is no need to customize the appearance of the query subject, use shortcuts.

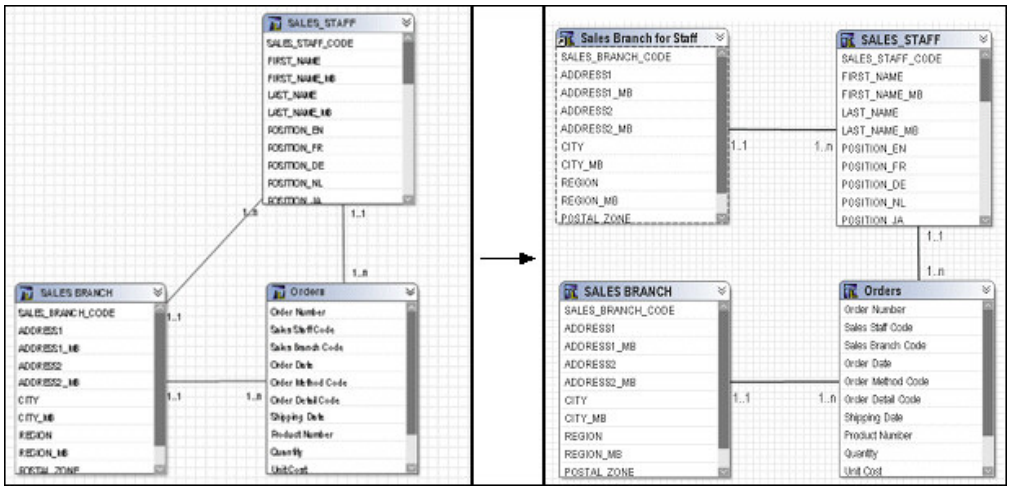
IBM Cognos Framework Manager has two types of shortcuts:

- regular shortcuts, which are a simple reference to the target object.
- alias shortcuts, which behave as if they were a copy of the original object with completely independent behavior. Alias shortcuts are available only for query subjects and dimensions.

Regular shortcuts are typically used as conformed dimensions with star schema groups, creating multiple references with the exact same name and appearance in multiple places. In the example below, the shortcuts created for Products and Order Time behave as references. If a query is written that brings Products from both Product Forecast and Sales Target, the query uses the definition of Products based on the original and this definition appears only once in the query.



Alias shortcuts are typically used in role-playing dimensions or shared tables. Because there is already an example in this document for role-playing dimensions, we will look at the case of shared tables. In this example, Sales Staff and Sales Branch can be treated as different hierarchies. From our knowledge of the data, we know that because staff can move between branches, we need to be able to report orders against Sales Branch and Sales Staff independently as well as together. To achieve this, we need to create an alias to Sales Branch that can be used as a level in the Sales Staff hierarchy.



With the new alias shortcut in place, it is possible to create queries that require orders by sales branch and orders by sales staff with their current branch information simultaneously.

When you open a model from a previous release, the **Shortcut Processing** governor is set to **Automatic**. When **Automatic** is used, shortcuts work the same as in previous releases, that is, a shortcut that exists in the same folder as its target behaves as an alias, or independent instance, whereas a shortcut existing elsewhere in the model behaves as a reference to the original. To take advantage of the **Treat As** property, it is recommended that you verify the model and, when repairing, change the governor to **Explicit**. The repair operation changes all shortcuts to the correct value from the **Treat As** property based on the rules followed by the

Automatic setting, this means that there should be no change in behavior of your model unless you choose to make one or more changes to the **Treat As** properties of your shortcuts.

When you create a new model, the **Shortcut Processing** governor is always set to **Explicit**.

When the governor is set to **Explicit**, the shortcut behavior is taken from the **Treat As** property and you have complete control over how shortcuts behave without being concerned about where in the model they are located.

Folders vs. Namespaces

The most important thing to know about namespaces is that once you have begun authoring reports, any changes you make to the names of published namespaces will impact your IBM Cognos content. This is because changing the name of the namespace changes the IDs of the objects published in the metadata. Because the namespace is used as part of the object ID in IBM Cognos Framework Manager, each namespace must have a unique name in the model. Each object in a namespace must also have a unique name. Part of the strategy of star schema groups is placing shortcuts into a separate namespace, which automatically creates a unique ID for each object in the namespace. For relational databases, this allows us to use the same name for shortcuts to conformed dimensions in different star schema groups.

The next time you try to run a query, report, or analysis against the updated model, you get an error. If you need to rename the namespace that you have published, use **Analyze Publish Impact** to determine which reports are impacted.

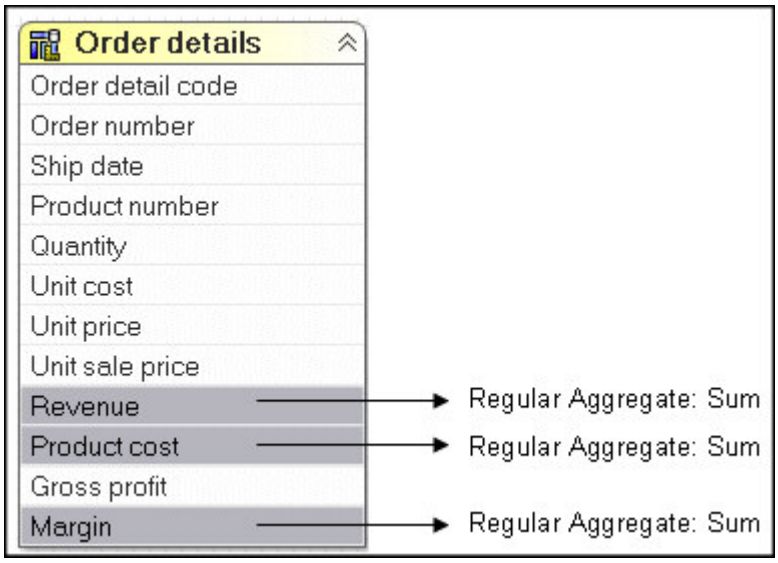
Folders are much simpler than namespaces. They are purely for organizational purposes and do not impact object IDs or your content. You can create folders to organize objects by subject or functional area. This makes it easier for you to locate metadata, particularly in large projects.

The main drawback of folders is that they require unique names for all query subjects, dimensions, and shortcuts. Therefore, they are not ideal for containing shared objects.

Setting the Order of Operations for Model Calculations

In some cases, usually for ratio-related calculations, it is useful to perform the aggregation on the calculation terms prior to the mathematical operation.

For example, the following Order details fact contains information about each order:



Margin is a calculation that computes the ratio of profit:

```
Margin = (Revenue - Product cost) / Revenue
```

If we run a query to show Revenue, Product cost, and Margin for each product using the Order details fact, we get the following results:

Product number	Revenue	Product cost	Margin
1	$23,057,141	$11,292,005	61038%
2	$11,333,518	$6,607,904	49606%

Notice that the value for Margin seems to be wrong. This is because of the order of operations used in computing Margin. Margin is computed as:

```
Margin = sum( (Revenue - Product cost) / Revenue )
```

The aggregation took place after the mathematical operation and, in this case, it produces undesired results.

To produce the desired values for Margin, we need to aggregate before the mathematical operation:

```
Margin = ( sum(Revenue) - sum(Product cost) ) / sum(Revenue)
```

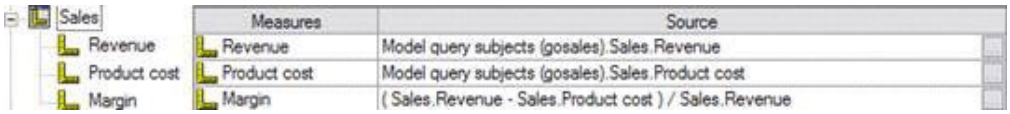
This produces the following results:

Product number	Revenue	Product cost	Margin
1	$23,057.141	$11,292,005	51.03%
2	$11,333,518	$6,607,904	41.70%

You can accomplish this in IBM Cognos Framework Manager by creating a stand-alone calculation for Margin and setting its **Regular Aggregate** property to **Calculated**. Each query item in the calculation's expression is aggregated as specified in its **Regular Aggregate** property. The **Regular Aggregate** properties for Revenue and Product cost are set to **Sum** and thus, when computing the calculation, sum is used to aggregate those terms.

Note: The calculated aggregation type is not supported for calculations that are embedded within query subjects. It is supported only for stand-alone calculations and for calculations that are embedded within measure dimensions and are based on measures from the same measure dimension.

For example, consider the Margin calculation that is embedded in the Sales measure dimension:



In this example, Margin is based on the measures Product cost and Revenue that are within the same measure dimension, Sales. If the **Regular Aggregate** property for Margin is set to **Calculated**, it is rolled up as:

```
Margin = sum(Revenue - Product cost ) / sum(Revenue)
```

If Margin is based on the source query items of the measures Product cost and Revenue (Sales (model).Product cost, Sales (model).Revenue), the calculated aggregation is not supported and the aggregation behaves as automatic. In this case, Margin is rolled up as:

```
Margin = sum( Revenue - Product cost) / Revenue)
```

For more information about modifying how query items are aggregated, see the IBM Cognos Framework Manager *User Guide*.

Impact of Model Size

The size of your model may affect the efficiency of the Framework Manager application.

Very large models will cause extended processing times and, in extreme cases, out-of-memory conditions. Actions such as Analyze Publish Impact, Find Report Dependencies, Publish Packages and Run Model Advisor perform optimally on models under 50 megabytes.

Dimensional Modeling Concepts

Regular and measure dimensions are used to enable an OLAP presentation of metadata, drilling up and down, and a variety of OLAP functions. You must use star schema groups (one fact with multiple dimensions) if you want to use IBM Cognos Analysis Studio with a relational data source.

When building your model, it is recommended that model regular dimensions and model measure dimensions be created based on a relational model in which star schema concepts have been applied.

While you can convert data source query subjects to data source dimensions, data source dimensions have limited functionality in comparison to query subjects or model dimensions, and they are not recommended for general use.

Regular Dimensions

Regular dimensions represent descriptive data that provides context for data modeled in measure dimensions. A regular dimension is broken into groups of information called levels. In turn, the various levels can be organized into hierarchies. For example, a product dimension can contain the levels Product Line,

Product Type, and Product organized in a single hierarchy called Product. Another example is a time dimension that has the levels Year, Quarter, Month, Week, and Day, organized into two hierarchies. The one hierarchy YQMD contains the levels Year, Quarter, Month, and Day, and the other hierarchy YWD contains the levels Year, Week, and Day.

The simplest definition of a level consists of a business key and a caption, each of these referring to one query item. An instance (or row) of a level is defined as a member of that level. It is identified by a member unique name, which contains the values of the business keys of the current and higher levels. For example, `[gosales].[Products].[ProductsOrg].[Product]->[All Products].[1].[1].[2]` identifies a member that is on the fourth level, `Product`, of the hierarchy `ProductsOrg` of the dimension `[Products]` that is in the namespace `[gosales]`. The caption for this product is TrailChef Canteen, which is the name shown in the metadata tree and on the report.

The level can be defined as unique if the business key of the level is sufficient to identify each set of data for a level. In the Great Outdoors Sales model, the members of the Product level do not require the definition of Product type because there are no product numbers assigned to many different product types. A level that is not defined as unique is similar to a determinant that uses multiple-part keys because keys from higher levels of granularity are required. See "Using Determinants with Multiple-Part Keys" on page 5. If members within ancestor members are not unique but the level is defined as unique, data for the non-unique members is reported as a single member. For example, if City is defined as unique and identified by name, data for London, England and London, Canada will be combined.

A regular dimension may also have multiple hierarchies; however, you can use only one hierarchy at a time in a query. For example, you cannot use one hierarchy in the rows of a crosstab report and another hierarchy from the same dimension in the columns. If you need both hierarchies in the same report, you must create two dimensions, one for each hierarchy.

Measure Dimensions

Measure dimensions represent the quantitative data described by regular dimensions. Known by many terms in various OLAP products, a measure dimension is simply the object that contains the fact data. Measure dimensions differ from fact query subjects because they do not include the foreign keys used to join a fact query subject to a dimensional query subject. This is because the measure dimension is not meant to be joined as if it were a relational data object. For query generation purposes, a measure dimension derives its relationship to a regular dimension through the underlying query subjects. Similarly the relationship to other measure dimensions is through regular dimensions that are based on query subjects built to behave as conformed dimensions. To enable multiple-fact, multiple-grain querying, you must have query subjects and determinants created appropriately before you build regular dimensions and measure dimensions.

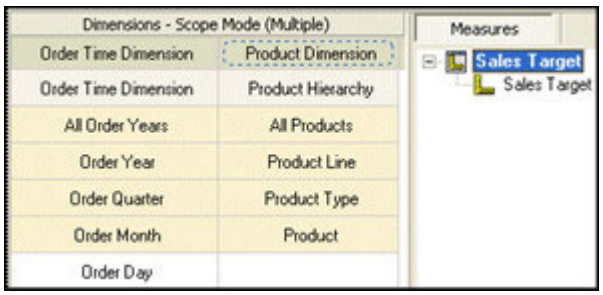
Scope Relationships

Scope relationships exist only between measure dimensions and regular dimensions to define the level at which the measures are available for reporting. They are not the same as joins and do not impact the `Where` clause. There are no conditions or criteria set in a scope relationship to govern how a query is formed, it specifies only if a dimension can be queried with a specified fact. The absence of

a scope relationship may result in an error at runtime or cause fact data to be rolled up at a high level than expected given the other items in the report.

If you set the scope relationship for the measure dimension, the same settings apply to all measures in the measure dimension. If data is reported at a different level for the measures in the measure dimension, you can set scope on a measure. You can specify the lowest level that the data can be reported on.

In this example, the Sales Target measure dimension has only one measure that is in scope to the Order Month level on the Order Time Dimension and to the Product level of the Product Dimension. This means that if your users try to drill beyond the month level, they will see repeated data.



Building the Relational Model

Dimensional modeling of relational data sources is available in IBM Cognos Framework Manager, however it depends on the existence of a sound relational model.

IBM Cognos ReportNet provided some dimensional capabilities to enable multiple-fact querying and to prevent double-counting. Subsequent to IBM Cognos ReportNet, the IBM Cognos software has features designed explicitly for dimensional representation of metadata and OLAP capability with relational data sources. The concepts applied to relational modeling in IBM Cognos ReportNet have been preserved with a few changes that are documented in the Framework Manager *User Guide*.

When you create a new Framework Manager model, you will follow a common set of steps to define query generation even if you do not intend to use dimensional modeling capabilities. You must dimensionally model a relational data source when you want to use it in IBM Cognos Analysis Studio, to enable drilling up and down in reports, or to access member functions in the studios.

Defining the Relational Modeling Foundation

A model is the set of related objects required for one or more related reporting applications. A sound relational model is the foundation for a dimensional model.

When you define the relational modeling foundation, consider the following:

- Importing the metadata. For information about importing, see the IBM Cognos Framework Manager *User Guide*.
- "Verifying Imported Metadata" on page 22.
- "Resolving Ambiguous Relationships" on page 22.

- Simplifying the relational model using star schema concepts by analyzing cardinality for facts and dimensions and by deciding where to put relationships and determinants "Model Design Considerations" on page 11.
- Add data security, if required. For information about data security, see the Framework Manager *User Guide*.

Then you can define the dimensional representation of the model if it is required, and organize the model for presentation.

Verifying Imported Metadata

After importing metadata, you must check the imported metadata.

Verify these areas:

- relationships and cardinality
- determinants
- the **Usage** property for query items
- the **Regular Aggregate** property for query items

Relationships and cardinality are discussed here. For information on the **Usage** and **Regular Aggregate** properties, see the Framework Manager *User Guide*.

Analyzing the Cardinality for Facts and Dimensions:

The cardinality of a relationship defines the number of rows of one table that is related to the rows of another table based on a particular set (or join) of keys. Cardinality is used by IBM Cognos software to infer which query subjects behave as facts or dimensions. The result is that IBM Cognos software can automatically resolve a common form of loop join that is caused by star schema data when you have multiple fact tables joined to a common set of dimension tables.

To ensure predictable queries, it is important to understand how cardinality is used and to correctly apply it in your model. It is recommended that you examine the underlying data source schema and address areas where cardinality incorrectly identifies facts or dimensions that could cause unpredictable query results. The **Model Advisor** feature in Framework Manager can be used to help you understand how the cardinality is interpreted.

For more information, see "Cardinality" on page 1.

Resolving Ambiguous Relationships

Ambiguous relationships occur when the data represented by a query subject or dimension can be viewed in more than one context or role, or can be joined in more than one way.

The most common ambiguous relationships are:

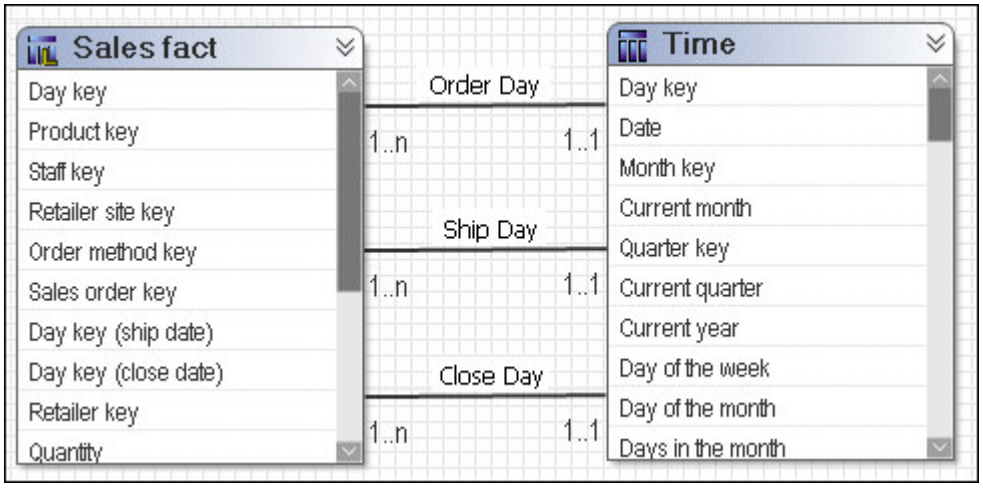
- "Role-Playing Dimensions" on page 23
- "Loop Joins" on page 26
- "Reflexive and Recursive Relationships" on page 27

You can use the **Model Advisor** to highlight relationships that may cause issues for query generation and resolve them in one of the ways described below. Note that there are other ways to resolve issues than the ones discussed here. The main goal is to enable clear query paths.

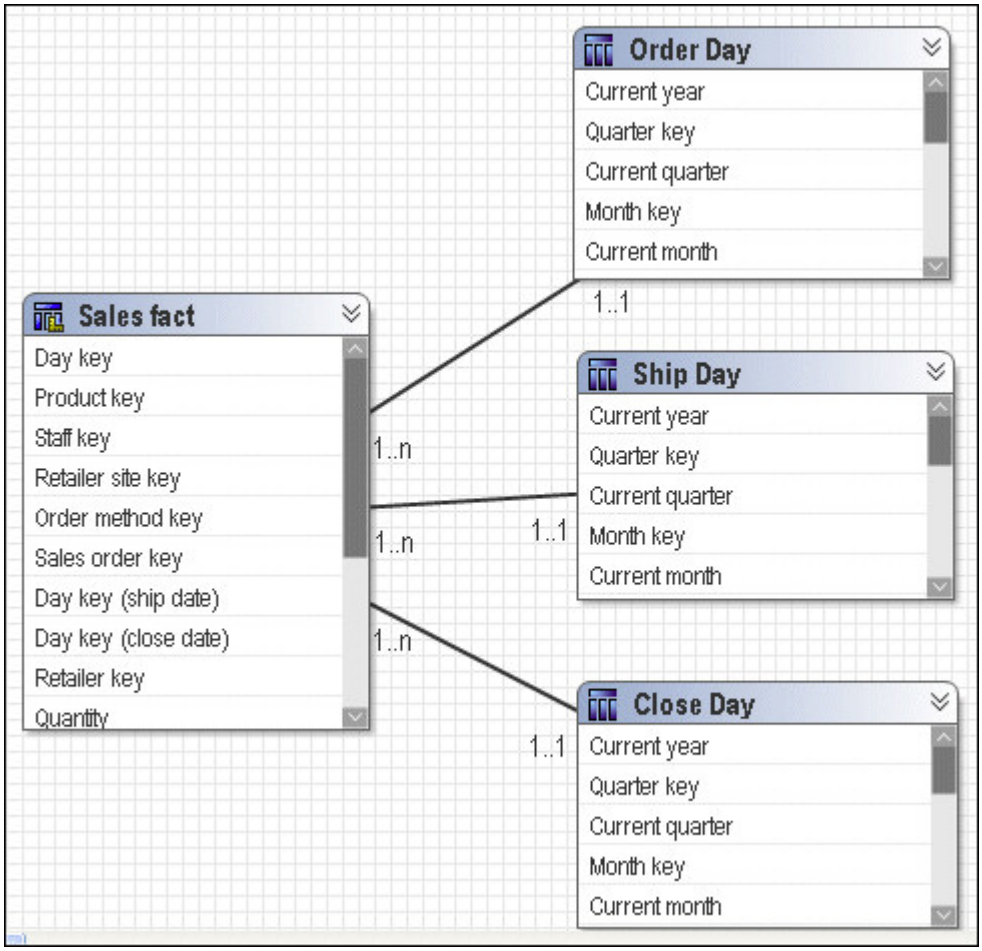
Role-Playing Dimensions:

A table with multiple valid relationships between itself and another table is known as a role-playing dimension. This is most commonly seen in dimensions such as Time and Customer.

For example, the Sales fact has multiple relationships to the Time query subject on the keys Order Day, Ship Day, and Close Day.



Remove the relationships for the imported objects, fact query subjects, and role-playing dimensional query subjects. Create a model query subject for each role. Consider excluding unneeded query items to reduce the length of the metadata tree displayed to your users. Ensure that a single appropriate relationship exists between each model query subject and the fact query subject. **Note:** This will override the **Minimized SQL** setting but given a single table representation of the Time dimension, it is not considered to be problematic in this case.

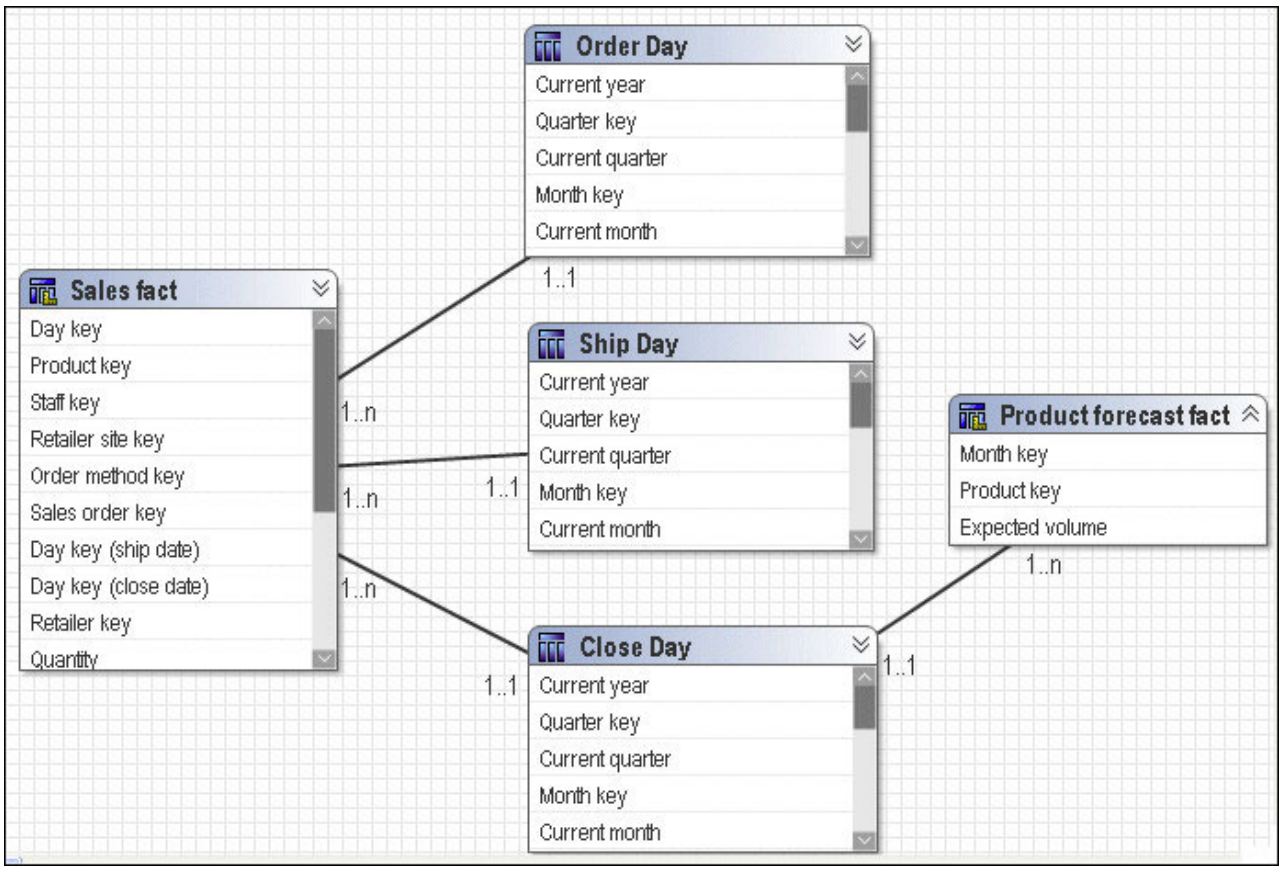


Decide how to use these roles with other facts that do not share the same concepts. For example, Product forecast fact has only one time key. You need to know your data and business to determine if all or any of the roles created for Time are applicable to Product forecast fact.

In this example, you can do one of the following:

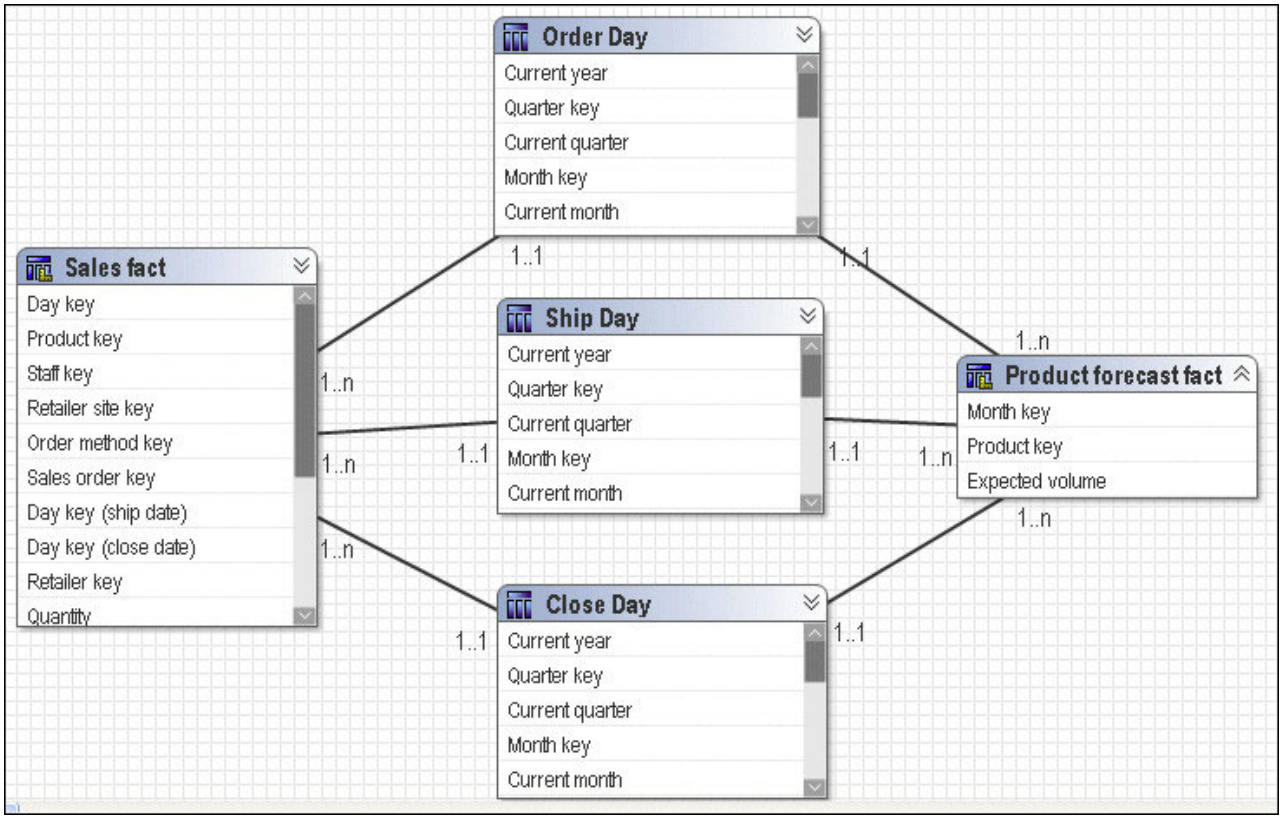
- Create an additional query subject to be the conformed time dimension and name it clearly as a conformed dimension.

  Pick the most common role that you will use. You can then ensure that this version is joined to all facts requiring it. In this example, Close Day has been chosen.



- You can treat Ship Day, Order Day, and Close Day as interchangeable time query subjects with Product forecast fact.

  In this case, you must create joins between each of the role-playing dimensions and Product forecast fact. You can use only one time dimension at a time when querying the Product forecast fact or your report may contain no data. For example, Month_key=Ship Month Key (200401) and Month key=Close Month Key (200312).



If modeling dimensionally, use each model query subject as the source for a regular dimension, and name the dimension and hierarchies appropriately. Ensure that there is a corresponding scope relationship specific to each role.

Loop Joins:

Loop joins in the model are typically a source of unpredictable behavior. This does not include star schema loop joins.

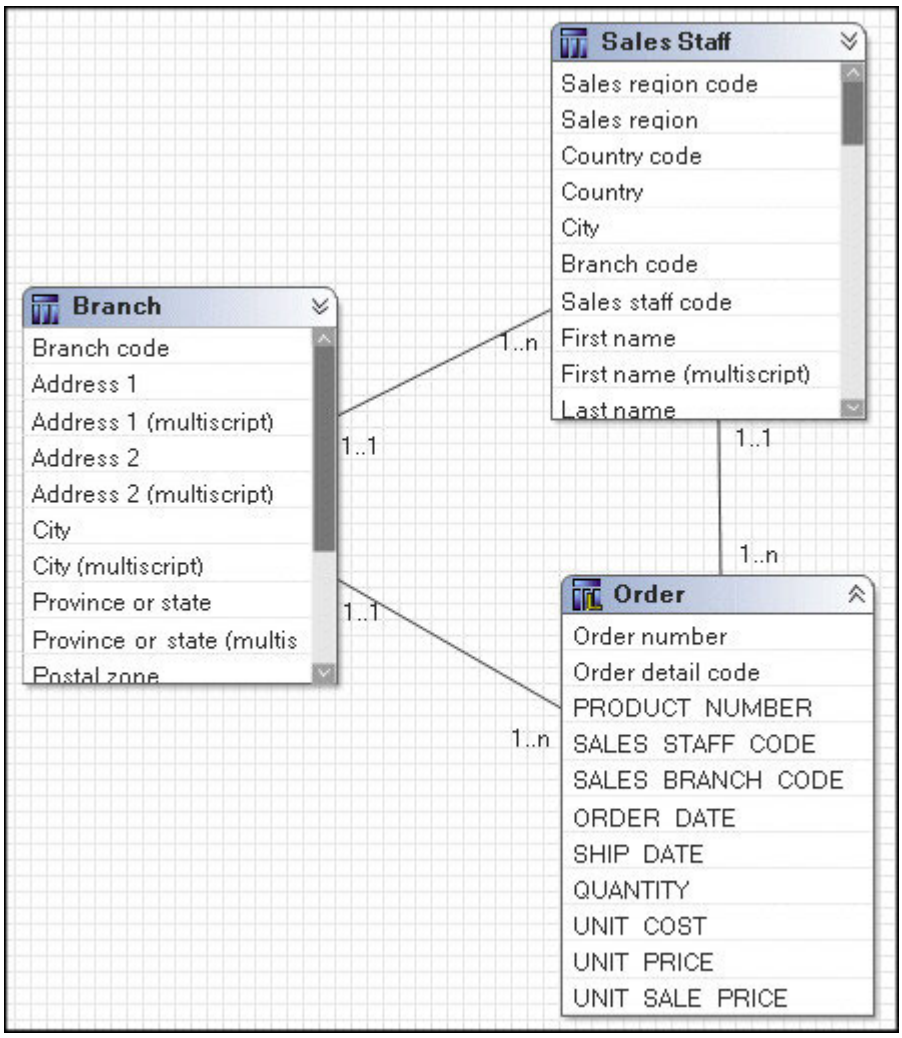
Note: When cardinality clearly identifies facts and dimensions, IBM Cognos software can automatically resolve loop joins that are caused by star schema data when you have multiple fact tables joined to a common set of dimension tables.

In the case of loop joins, ambiguously defined query subjects are the primary sign of problems. When query subjects are ambiguously defined and are part of a loop join, the joins used in a given query are decided based on a number of factors, such as the location of relationships, the number of segments in join paths, and, if all else is equal, the alphabetically first join path. This creates confusion for your users and we recommend that you model to clearly identify the join paths.

Sales Staff and Branch provide a good example of a loop join with ambiguously defined query subjects.

In this example, it is possible to join Branch directly to Order or through Sales Staff to Order. The main problem is that when Branch and Order are together, you get a different result than when the join path is Branch to Sales Staff to Order. This is because employees can move between branches so employees who moved during the year are rolled up to their current branch even if many of the sales they made are attributable to their previous branch. Because of the way this is modeled, there

is no guarantee which join path will be chosen and it is likely to vary depending on which items are selected in the query.

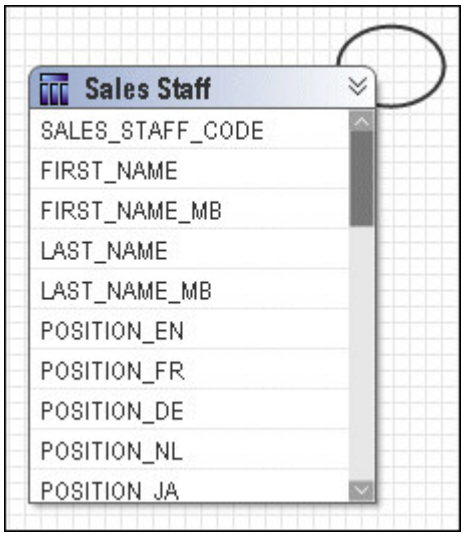


Reflexive and Recursive Relationships:

Reflexive and recursive relationships imply two or more levels of granularity. IBM Cognos Framework Manager imports reflexive relationships but does not use them when executing queries. Reflexive relationships, which are self-joins, are shown in the model for the purpose of representation only.

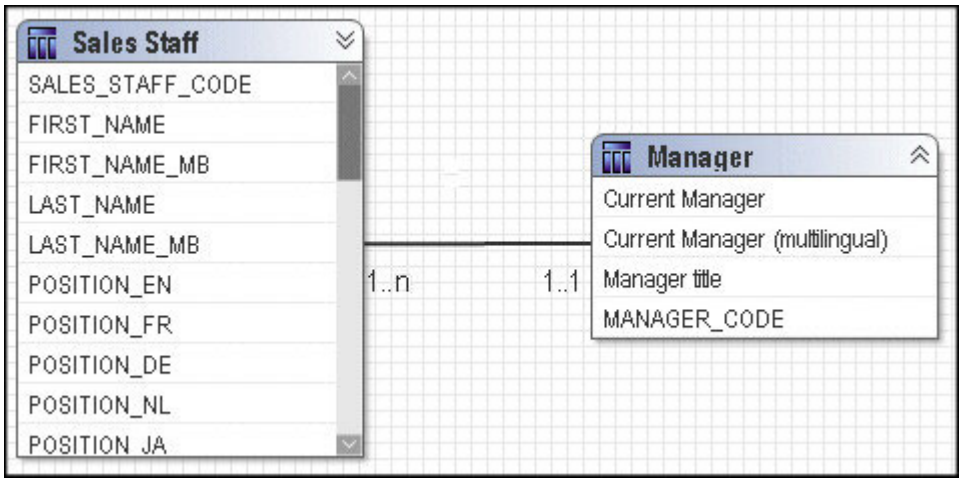
To create a functioning reflexive relationship, you can either create an alias shortcut, a copy of the data source query subject, or a model query subject. You then create a relationship between the original query subject and the new one. Using a model query subject tends to be the better option for flexibility because you can specify which query items are included in the query subject. Shortcuts are the better solution from a maintenance perspective. For more information, see "Model Objects vs. Shortcuts" on page 15.

For example, the Sales Staff query subject has a recursive relationship between Sales_Staff_Code and Manager_Code.



Create a model query subject to represent Manager. Create a relationship with a `1..1` to `1..n` between Manager and Sales Staff. Then merge into a new model query subject.

For a simple two-level structure using a model query subject for Manager that is based on Sales Staff, the model looks like this:



For a recursive, balanced hierarchy, repeat this for each additional level in the hierarchy.

For a deep recursive or unbalanced hierarchy, we recommend that the hierarchy be flattened in the data source and that you model the flattened hierarchy in one regular dimension.

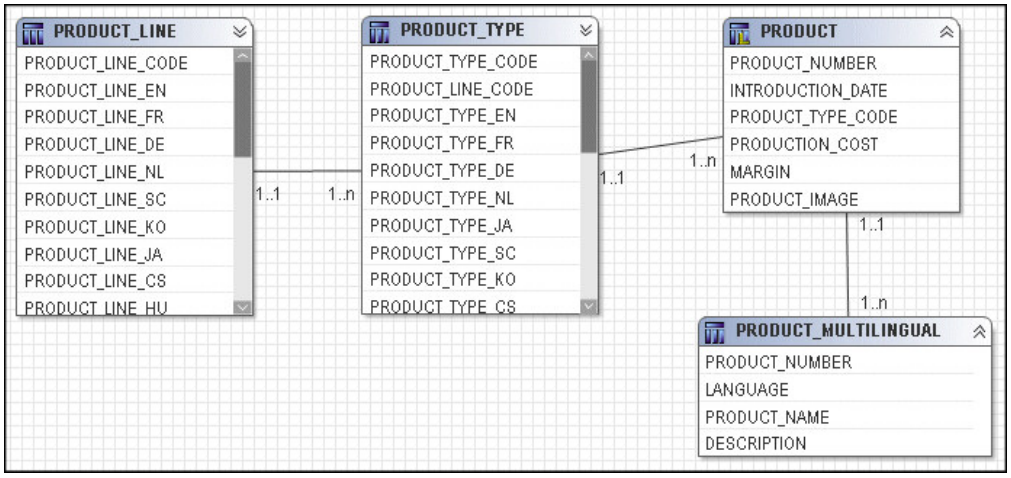
Simplifying the Relational Model

You can simplify the model by applying star schema concepts to the dimensional data and the fact data.

Modeling Query Subjects That Represent Descriptive Data:

IBM Cognos dimensional modeling requires that you apply star schema principles to the logical layers of the model.

Normalized or snowflaked data sources often have several tables that describe a single business concept. For example, a normalized representation of Product may include four tables related by `1..n` relationships. Each Product Line has one or more Product Types. Each Product Type has one or more Products. Products have names and descriptions in multiple languages so they exist in the Product Multilingual lookup table.

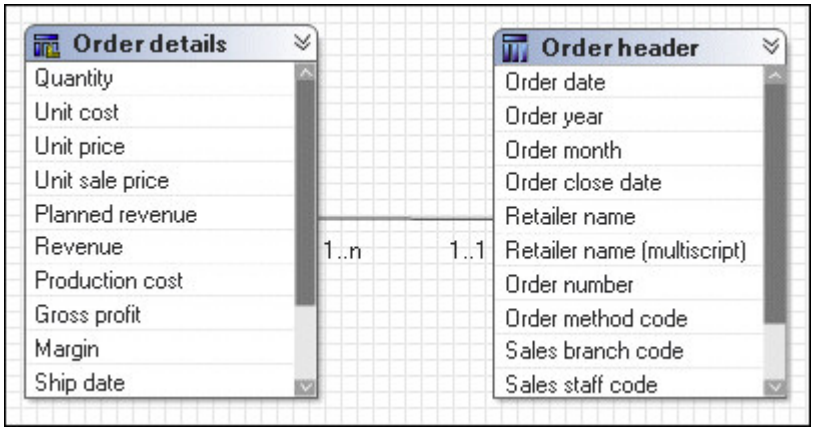


One way to simplify the model is to create one model query subject for each descriptive business concept. Your users may not know the relationship between the individual query subjects so it is helpful to group them together; in addition, having to expand each model object and select a query item requires more effort.

The next step for analysis is to create a regular dimension with a level for each query subject.

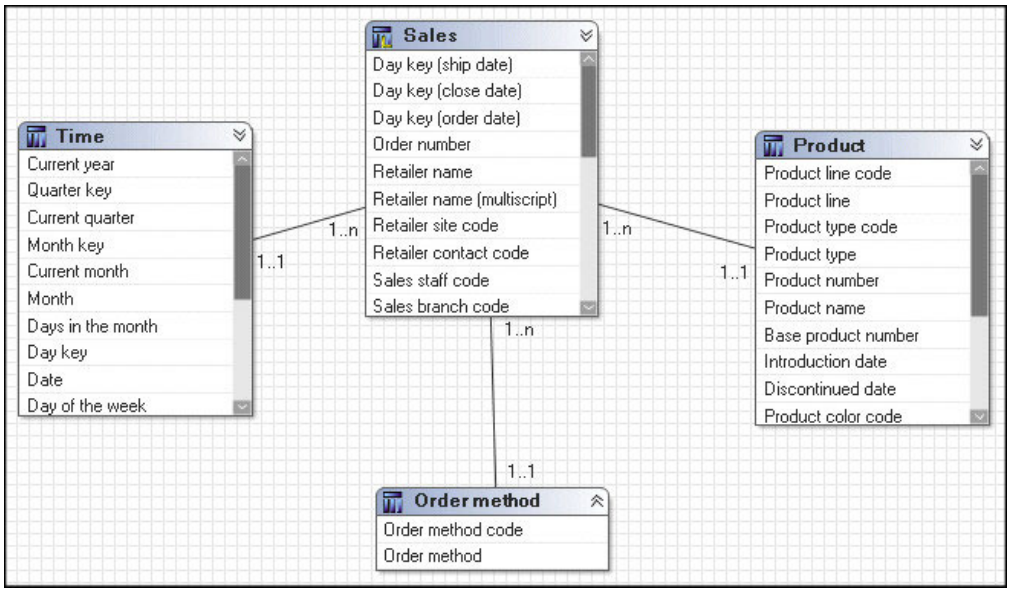
Modeling Fact Data:

Data sources often have master-detail tables that contain facts. For example, when the Order header and Order details tables are used to insert and update data, the master-detail structure is beneficial. When these tables are used for reporting and analysis, you may choose to combine them into one logical business concept to simplify the model. Or you may choose to insert a dimension between them, such as Returned Items. Which solution you choose depends on your requirements.



To simplify the model in this example, apply star schema concepts to create one model query subject that combines the foreign keys of both Order header and Order details and includes all measures at the Order details level. This query subject should be joined to the same query subjects that Order header and Order details were joined to. You may choose to remove the original relationships from the two data source query subjects except for the relationship that defines the join between them. For a discussion of the pros and cons of creating relationships to model query subjects, see the examples in "What Is Minimized SQL?" on page 12.

In the example below, Order header and Order details have been combined into a new model query subject named Sales. This query subject has been joined to Product, Time, and Order method.



The next step for analysis is to create a measure dimension based on the model query subject.

Defining the Dimensional Representation of the Model

Dimensional modeling of relational data sources is a capability made available by IBM Cognos Framework Manager. You can model dimensions with hierarchies and levels and have facts with multiple measures. You can then relate the dimensions to the measures by setting scope in the model.

You must dimensionally model a relational data source when you want to use it in IBM Cognos Analysis Studio, enable drilling up and down in reports, or access member functions in the studios.

You can use the relational model as the foundation layer and then define the dimensional representation of the model.

Then you can organize the model for presentation. See "Organizing the Model" on page 34.

Creating Regular Dimensions

A regular dimension contains descriptive and business key information and organizes the information in a hierarchy, from the highest level of granularity to

the lowest. It usually has multiple levels and each level requires a key and a caption. If you do not have a single key for your level, it is recommended that you create one in a calculation.

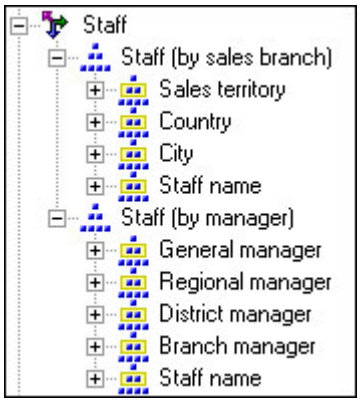
Model regular dimensions are based on data source or model query subjects that are already defined in the model. You must define a business key and a string type caption for each level. When you verify the model, the absence of business keys and caption information is detected. Instead of joining model regular dimensions to measure dimensions, create joins on the underlying query subjects and create a scope relationship between the regular dimension and the measure dimension.

Modeling Dimensions with Multiple Hierarchies

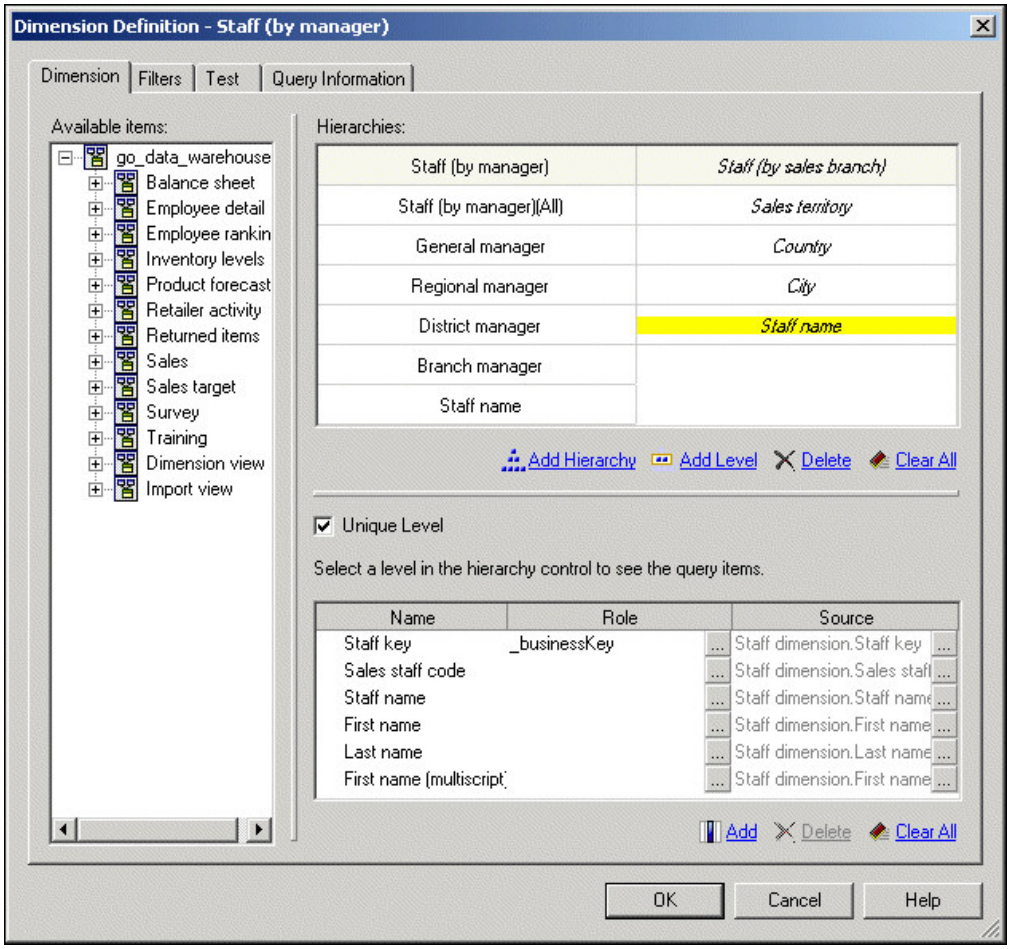
Multiple hierarchies occur when different structural views can be applied to the same data. Depending on the nature of the hierarchies and the required reports, you may need to evaluate the modeling technique applied to a particular case.

For example, sales staff can be viewed by manager or geography. In the IBM Cognos studios, these hierarchies are separate but interchangeable logical structures, which are bound to the same underlying query.

Here is sales staff as a single dimension with two hierarchies:

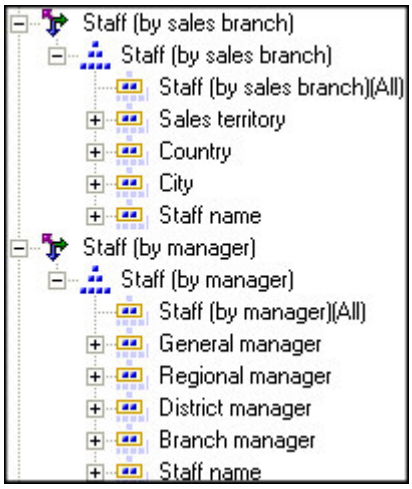


The hierarchies are defined in Framework Manager as follows.



You can specify multiple hierarchies on regular dimensions in Framework Manager. Multiple hierarchies for a regular dimension behave as views of the same query. However, you can use only one hierarchy at a time in a query. For example, you cannot use one hierarchy in the rows of a crosstab report and another hierarchy from the same dimension in the columns. If you need both hierarchies in the same report, you must create two dimensions, one for each hierarchy. In cases where you have multiple hierarchies with significantly different levels or aggregation, you may choose to model so that a separate query subject with appropriate determinants exists as the foundation for that hierarchy. The only requirement is that any query subject used as the basis for a hierarchy must have a join defined to the query subject that provides the fact data.

Here are separate dimensions for each hierarchy.



Use this approach if dramatically different sets of columns are relevant for each hierarchy and it is more intuitive for your users to model the hierarchies as separate dimensions with separate and simpler queries.

Creating Measure Dimensions

A measure dimension is a collection of facts. You can create a measure dimension for one or more query subjects that have a valid relationship between them.

Model measure dimensions should be composed of only quantitative items. Because, by design, model measure dimensions do not contain keys on which to join, it is not possible to create joins to model measure dimensions. Instead of joining model measure dimensions to regular dimensions, create joins on the underlying query subjects. Then either manually create a scope relationship between them or detect scope if both dimensions are in the same namespace.

Create Scope Relationships

Scope relationships exist only between measure dimensions and regular dimensions to define the level at which the measures are available for reporting. They are not the same as joins and do not impact the `Where` clause. There are no conditions or criteria set in a scope relationship to govern how a query is formed, it specifies only if a dimension can be queried with a specified fact. The absence of a scope relationship results in an error at runtime.

If you set the scope relationship for the measure dimension, the same settings apply to all measures in the measure dimension. If data is reported at a different level for the measures in the measure dimension, you can set scope on a measure. You can specify the lowest level that the data can be reported on.

When you create a measure dimension, IBM Cognos Framework Manager creates a scope relationship between the measure dimension and each existing regular dimension. Framework Manager looks for a join path between the measure dimension and the regular dimensions, starting with the lowest level of detail. If there are many join paths available, the scope relationship that Framework Manager creates may not be the one that you intended. In this case, you must edit the scope relationship.

Organizing the Model

After working in the relational modeling foundation and creating a dimensional representation, you can organize the model.

- Keep the metadata from the data source in a separate namespace or folder.
- Create one or more optional namespaces or folders for resolving complexities that affect querying using query subjects.

  To use IBM Cognos Analysis Studio, there must be a namespace or folder in the model that represents the metadata with dimensional objects.
- Create one or more namespaces or folders for the augmented business view of the metadata that contains shortcuts to dimensions or query subjects.

  Use business concepts to model the business view. One model can contain many business views, each suited to a different user group. You publish the business views.
- Create "Star Schema Groups."
- Apply object security, if required.
- Create packages and publish the metadata.

For information about the topics not covered here, see the Framework Manager *User Guide*.

Star Schema Groups

The concept of the conformed dimension is not isolated to dimensional modeling, it applies equally to query subjects.

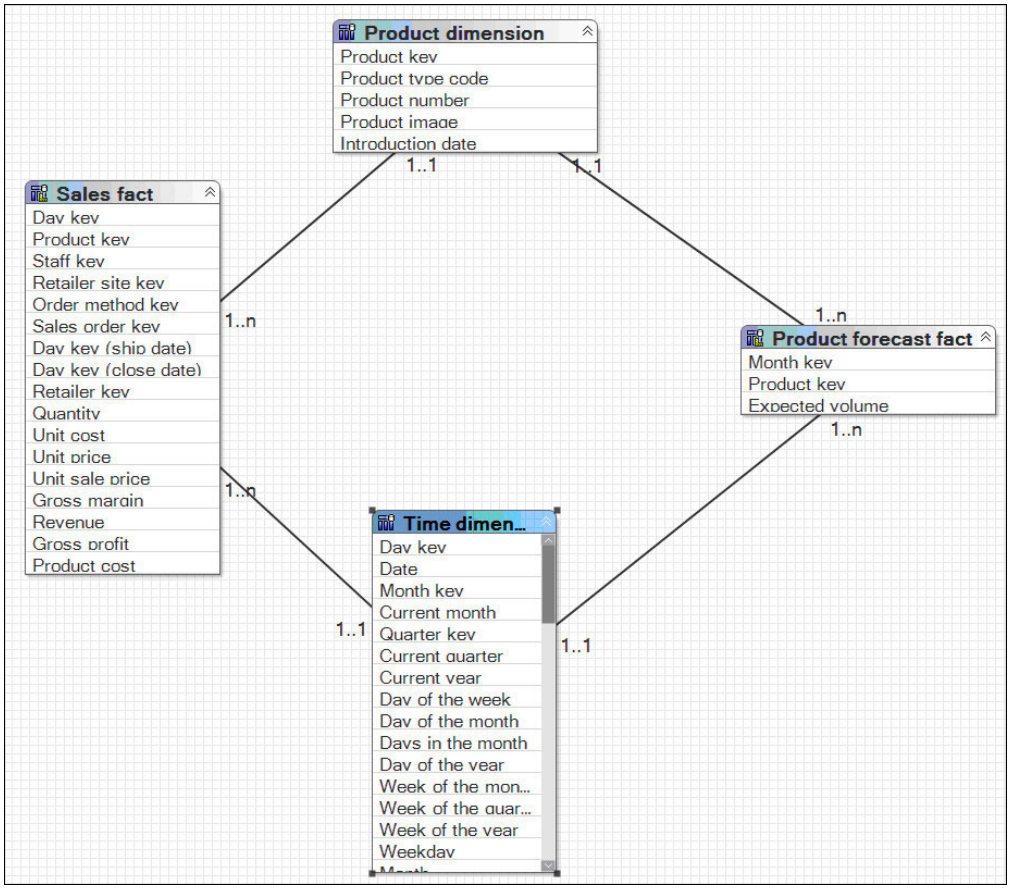
Use the **Star Schema Grouping** wizard to quickly create groups of shortcuts that will provide context for your users regarding which objects belong together. This makes the model more intuitive for your users. Star schema groups can also facilitate multiple-fact reporting by allowing the repetition of shared dimensions in different groups. This helps your users to see what different groups have in common and how they can do cross-functional, or multiple-fact, reporting. For more information, see "Multiple-fact, Multiple-grain Queries" on page 8.

Star schema groups also provide context for queries with multiple join paths. By creating star schema groups in the business view of the model, you can clarify which join path to select when many are available. This is particularly useful for fact-less queries.

Multiple Conformed Star Schemas or Fact-less Queries:

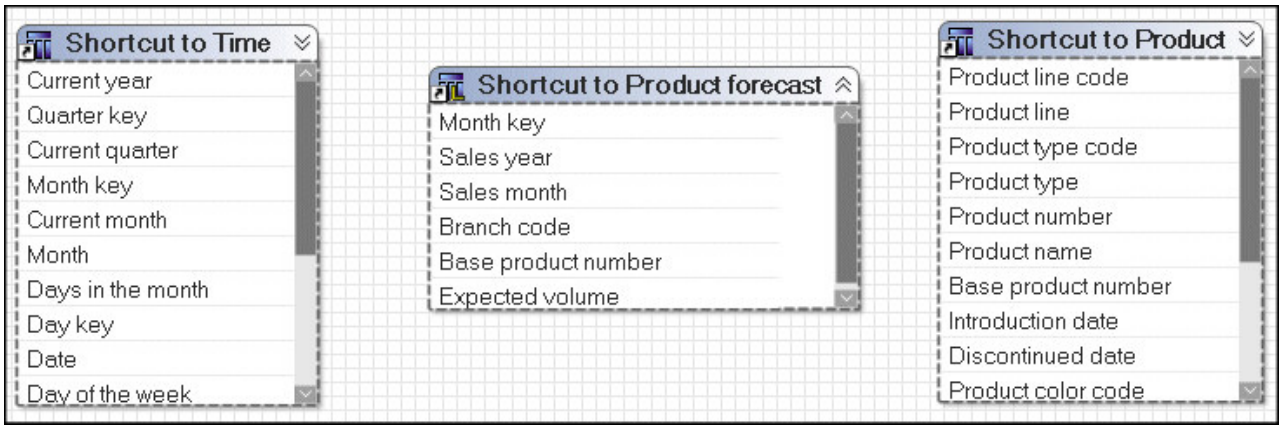
You will likely see dimensional query subjects that are joined to more than one fact query subject. Join ambiguity is an issue when you report using items from multiple dimensions or dimensional query subjects without including any items from the measure dimension or fact query subject. This is called a fact-less query.

For example, Product and Time dimensions are related to the Product forecast and Sales facts.



Using these relationships, how do you write a report that uses only items from Product and Time? The business question could be which products were forecasted for sale in 2005 or which products were actually sold in 2005. Although this query involves only Product and Time, these dimensions are related through multiple facts. There is no way to guess which business question is being asked. You must set the context for the fact-less query.

In this example, we recommend that you create two namespaces, one containing shortcuts to Product, Time, and Product forecast, and another containing Product, Time, and Sales.



When you do this for all star schemas, you resolve join ambiguity by placing shortcuts to the fact and all dimensions in a single namespace. The shortcuts for conformed dimensions in each namespace are identical and are references to the original object. **Note:** The exact same rule is applied to regular dimensions and measure dimensions.

With a namespace for each star schema, it is now clear to your users which items to use. To create a report on which products were actually sold in 2005, they use Product and Year from the Sales Namespace. The only relationship that is relevant in this context is the relationship between Product, Time, and Sales, and it is used to return the data.

Chapter 2. The SQL Generated by IBM Cognos Software

The SQL generated by IBM Cognos software is often misunderstood. This document explains the SQL that results in common situations.

Note: The SQL examples shown in this document were edited for length and are used to highlight specific examples. These examples use the version 8.2 sample model.

To access the IBM Cognos *Guidelines for Modeling Metadata* documentation in a different language, go to *installation_location*\c10\webcontent\documentation and open the folder for the language you want. Then open ug_best.pdf.

Understanding Dimensional Queries

Dimensional queries are designed to enable multiple-fact querying.

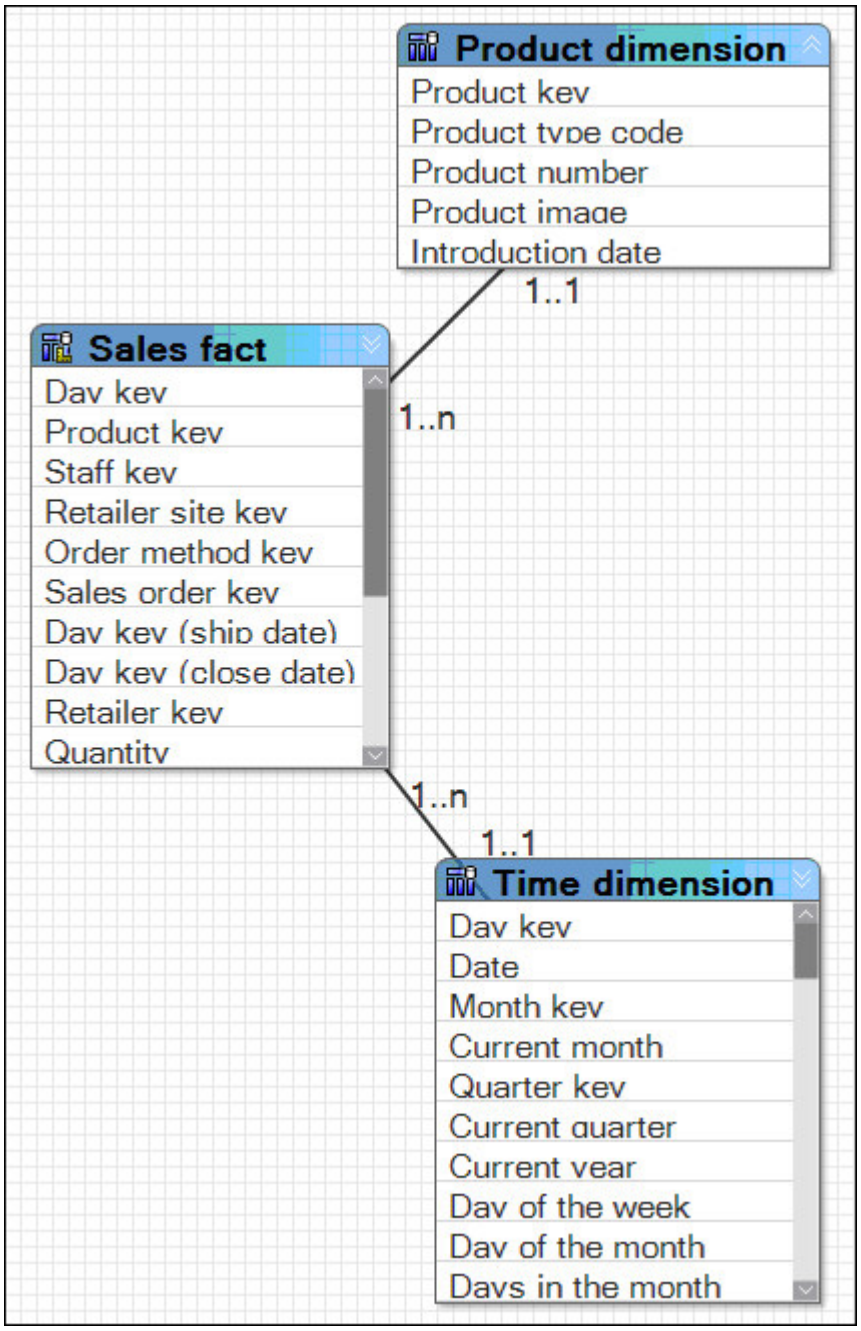
The basic goals of multiple-fact querying are:

- Preserve data when fact data does not perfectly align across common dimensions, such as when there are more rows in the facts than in the dimensions.
- Prevent double-counting when fact data exists at different levels of granularity by ensuring that each fact is represented in a single query with appropriate grouping. Determinants may need to be created for the underlying query subjects in some cases.

Single Fact Query

A query on a star schema group results in a single fact query.

In this example, Sales is the focus of any query written. The dimensions provide attributes and descriptions to make the data in Sales more meaningful. All relationships between dimensions and the fact are 1-n.



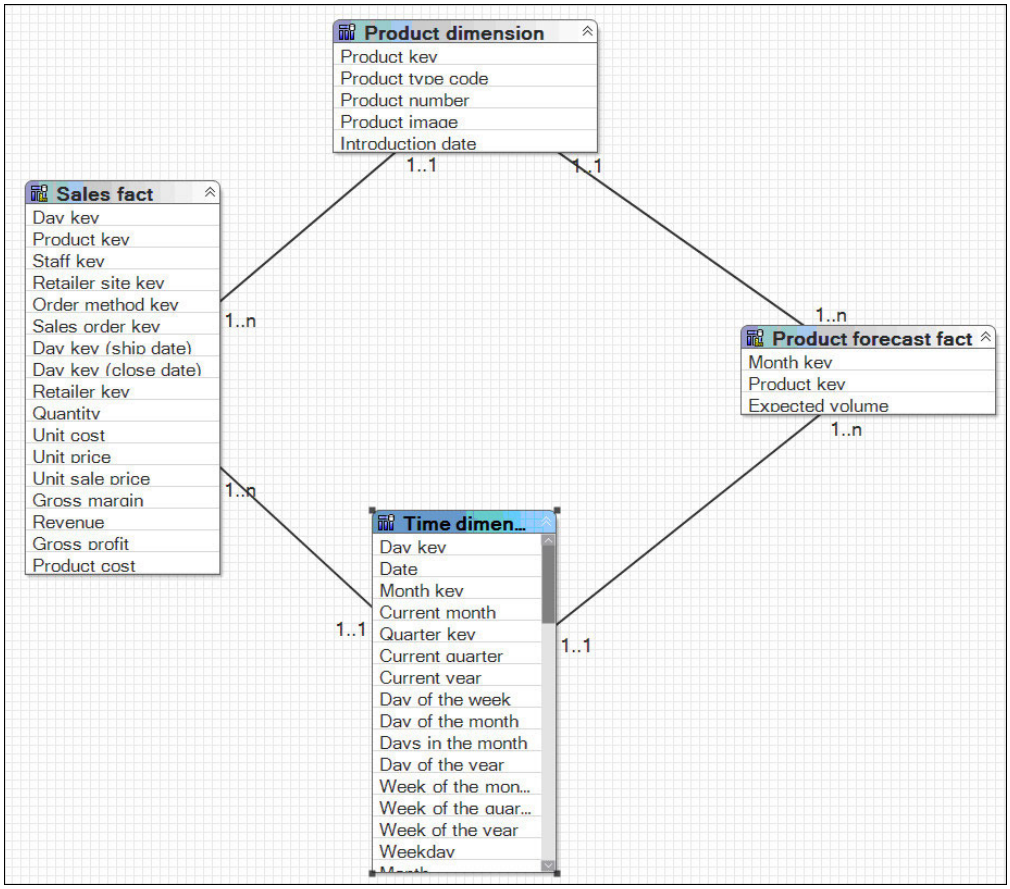
When you filter on the month and product, the result is as follows.

MONTH_NAME	PRODUCT_NAME	QUANTITY
April 2004	Aloe Relief	1,410
April 2004	Course Pro Umbrella	132
February 2004	Aloe Relief	270
February 2006	Aloe Relief	88

Multiple-fact, Multiple-grain Query on Conformed Dimensions

A query on multiple facts and conformed dimensions respects the cardinality between each fact table and its dimensions and writes SQL to return all the rows from each fact table.

For example, Sales and Product Forecast are both facts.



Note that this is a simplified representation and not an example of how this would appear in a model built using IBM Cognos modeling recommendations.

The Result

Individual queries on Sales and Product Forecast by Month and Product yield the following results. The data in Sales is actually stored at the day level.

MONTH_NAME	PRODUCT_NAME	EXPECTED_VOLUME
April 2004	Aloe Relief	1,690
April 2004	Course Pro Umbrella	125
February 2004	Aloe Relief	246
February 2004	Course Pro Umbrella	1
February 2006	Aloe Relief	92

A query on Sales and Product Forecast respects the cardinality between each fact table and its dimensions and writes SQL to return all the rows from each fact table. The fact tables are matched on their common keys, month and product, and, where possible, are aggregated to the lowest common level of granularity. In this case, days are rolled up to months. Nulls are often returned for this type of query because a combination of dimensional elements in one fact table may not exist in the other.

MONTH_NAME	PRODUCT_NAME	QUANTITY	EXPECTED_VOLUME
April 2004	Aloe Relief	1,410	1,690
April 2004	Course Pro Umbrella	132	125
February 2004	Aloe Relief	270	246
February 2004	Course Pro Umbrella		1
February 2006	Aloe Relief	88	92

Note that in February 2004, Course Pro Umbrellas were in the forecast but there were no actual sales. The data in Sales and Product Forecast exist at different levels of granularity. The data in Sales is at the day level, and Product Forecast is at the month level.

The SQL

The SQL generated by IBM Cognos software, known as a stitched query, is often misunderstood. A stitched query uses multiple subqueries, one for each star, brought together by a full outer join on the common keys. The goal is to preserve all dimensional members occurring on either side of the query.

The following example was edited for length and is used as an example to capture the main features of stitched queries.

```
select
 coalesce(D2.MONTH_NAME,D3.MONTH_NAME) as MONTH_NAME,
 coalesce(D2.PRODUCT_NAME,D3.PRODUCT_NAME) as PRODUCT_NAME,
 D2.EXPECTED_VOLUME as EXPECTED_VOLUME,
 D3.QUANTITY as QUANTITY
from (select TIME.MONTH_NAME as MONTH_NAME,
 PRODUCT_LOOKUP.PRODUCT_NAME as PRODUCT_NAME,
 XSUM(PRODUCT_FORECAST_FACT.EXPECTED_VOLUME for
 TIME.CURRENT_YEAR,TIME.QUARTER_KEY,TIME.MONTH_KEY,
 PRODUCT.PRODUCT_LINE_CODE, PRODUCT.PRODUCT_TYPE_CODE,
 PRODUCT.PRODUCT_KEY) as EXPECTED_VOLUME
from
 (select TIME.CURRENT_YEAR as CURRENT_YEAR,
 TIME.QUARTER_KEY as QUARTER_KEY,
 TIME.MONTH_KEY as MONTH_KEY,
 XMIN(TIME.MONTH_NAME for TIME.CURRENT_YEAR,
 TIME.QUARTER_KEY,TIME.MONTH_KEY) as MONTH_NAME
 from TIME_DIMENSION TIME
 group by TIME.MONTH_KEY) TIME
 join PRODUCT_FORECAST_FACT PRODUCT_FORECAST_FACT
 on (TIME.MONTH_KEY = PRODUCT_FORECAST_FACT.MONTH_KEY)
 join PRODUCT PRODUCT on (PRODUCT.PRODUCT_KEY =
 PRODUCT_FORECAST_FACT.PRODUCT_KEY)
where
 (PRODUCT.PRODUCT_NAME in ('Aloe Relief','Course Pro
Umbrella')) and
 (TIME.MONTH_NAME in ('April 2004','February 2004','February
```

```
2006'))
group by
 TIME.MONTH_NAME,
 PRODUCT_LOOKUP.PRODUCT_NAME
) D2
 full outer join
(select TIME.MONTH_NAME as MONTH_NAME,
 PRODUCT_LOOKUP.PRODUCT_NAME as PRODUCT_NAME,
 XSUM(SALES_FACT.QUANTITY for TIME.CURRENT_YEAR,
 TIME.QUARTER_KEY, TIME.MONTH_KEY,
 PRODUCT.PRODUCT_LINE_CODE, PRODUCT.PRODUCT_TYPE_CODE,
 PRODUCT.PRODUCT_KEY ) as QUANTITY
from
select TIME.DAY_KEY,TIME.MONTH_KEY,TIME.QUARTER_KEY,
 TIME.CURRENT_YEAR,TIME.MONTH_EN as MONTH_NAME
 from TIME_DIMENSION TIME) TIME
 join SALES_FACT SALES_FACT
 on (TIME.DAY_KEY = SALES_FACT.ORDER_DAY_KEY)
 join PRODUCT PRODUCT on (PRODUCT.PRODUCT_KEY = SALES_FACT.PRODUCT_KEY)
where
 PRODUCT.PRODUCT_NAME in ('Aloe Relief','Course Pro Umbrella'))
 and (TIME.MONTH_NAME in ('April 2004','February 2004','February
2006'))
 group by
 TIME.MONTH_NAME,
 PRODUCT.PRODUCT_NAME
) D3
 on ((D2.MONTH_NAME = D3.MONTH_NAME) and
 (D2.PRODUCT_NAME = D3.PRODUCT_NAME))
```

What Is the Coalesce Statement?

A coalesce statement is simply an efficient means of dealing with query items from conformed dimensions. It is used to accept the first non-null value returned from either query subject. This statement allows a full list of keys with no repetitions when doing a full outer join.

Why Is There a Full Outer Join?

A full outer join is necessary to ensure that all the data from each fact table is retrieved. An inner join gives results only if an item in inventory was sold. A right outer join gives all the sales where the items were in inventory. A left outer join gives all the items in inventory that had sales. A full outer join is the only way to learn what was in inventory and what was sold.

Modeling 1-n Relationships as 1-1 Relationships

If a 1-n relationship exists in the data but is modeled as a 1-1 relationship, SQL traps cannot be avoided because the information provided by the metadata to the IBM Cognos software is insufficient.

The most common problems that arise if 1-n relationships are modeled as 1-1 are the following:

- Double-counting for multiple-grain queries is not automatically prevented.

  IBM Cognos software cannot detect facts and then generate a stitched query to compensate for double-counting, which can occur when dealing with hierarchical relationships and different levels of granularity across conformed dimensions.
- Multiple-fact queries are not automatically detected.

IBM Cognos software will not have sufficient information to detect a multiple-fact query. For multiple-fact queries, an inner join is performed and the loop join is eliminated by dropping the last evaluated join. Dropping a join is likely to lead to incorrect or unpredictable results depending on the dimensions and facts included in the query.

If the cardinality were modified to use only 1-1 relationships between query subjects or dimensions, the result of a query on Product Forecast and Sales with Time or Time and Product generates a single `Select` statement that drops one join to prevent a circular reference.

The example below shows that the results of this query are incorrect when compared with the results of individual queries against Sales or Product Forecast.

The results of individual queries are as follows.

MONTH_NAME	PRODUCT_NAME	QUANTITY
April 2004	Aloe Relief	1,410
April 2004	Course Pro Umbrella	132
February 2004	Aloe Relief	270
February 2006	Aloe Relief	88

MONTH_NAME	PRODUCT_NAME	EXPECTED_VOLUME
April 2004	Aloe Relief	1,690
April 2004	Course Pro Umbrella	125
February 2004	Aloe Relief	246
February 2004	Course Pro Umbrella	1
February 2006	Aloe Relief	92

When you combine these queries into a single query, the results are as follows.

MONTH_NAME	PRODUCT_NAME	QUANTITY	EXPECTED_VOLUME
April 2004	Aloe Relief	68,598	1,811,680
April 2004	Course Pro Umbrella	68,598	134,000
February 2004	Aloe Relief	29,672	105,780
February 2004	Course Pro Umbrella	29,672	430
February 2006	Aloe Relief	28,564	47,196

The SQL

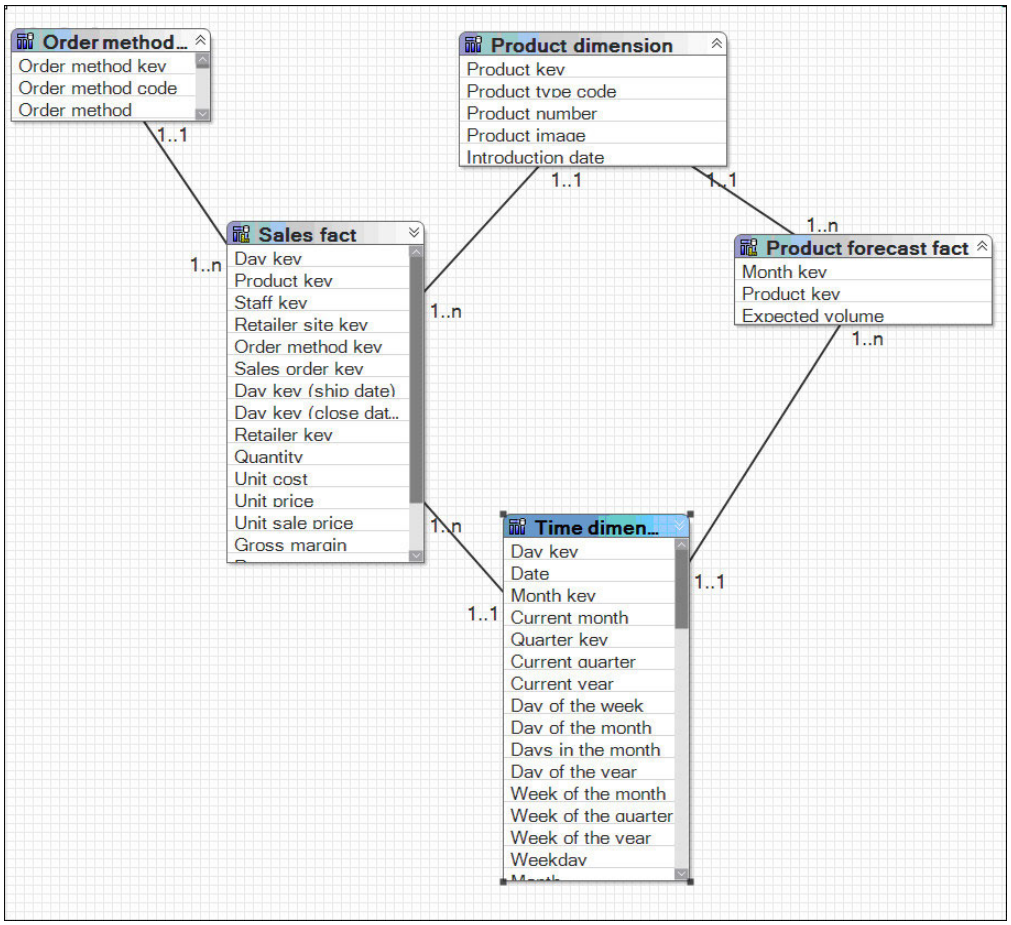
Because a circular join path was detected in the model, the generated SQL did not include one of the relationships that was not necessary to complete the join path. In this example, the relationship between Time and Product Forecast was dropped.

A circular join path rarely results in a query that produces useful results.

```
select
 TIME_.MONTH_NAME as MONTH_NAME,
 PRODUCT_LOOKUP.PRODUCT_NAME as PRODUCT_NAME,
 XSUM(SALES_FACT.QUANTITY for
 TIME_.CURRENT_YEAR, TIME_.QUARTER_KEY, TIME_.MONTH_KEY,
 PRODUCT.PRODUCT_LINE_CODE, PRODUCT.PRODUCT_TYPE_CODE,
 PRODUCT.PRODUCT_KEY ) as QUANTITY,
 XSUM(PRODUCT_FORECAST_FACT.EXPECTED_VOLUME for TIME_.CURRENT_YEAR,
 TIME_.QUARTER_KEY, TIME_.MONTH_KEY, PRODUCT.PRODUCT_LINE_CODE,
 PRODUCT.PRODUCT_TYPE_CODE, PRODUCT.PRODUCT_KEY ) as EXPECTED_VOLUME
from
 (select TIME.DAY_KEY,TIME.MONTH_KEY, TIME.QUARTER_KEY,
 TIME.CURRENT_YEAR,TIME.MONTH_EN as MONTH_NAME
 from TIME_DIMENSION TIME) TIME
 join
 SALES_FACT on (TIME_.DAY_KEY = SALES_FACT.ORDER_DAY_KEY)
 join
 PRODUCT_FORECAST_FACT on (TIME_.MONTH_KEY =
 PRODUCT_FORECAST_FACT.MONTH_KEY)
 join
 PRODUCT (PRODUCT.PRODUCT_KEY = PRODUCT_FORECAST_FACT.PRODUCT_KEY)
where
 (PRODUCT.PRODUCT_NAME in ('Aloe Relief','Course Pro Umbrella'))
and
 (TIME_.MONTH_NAME in ('April 2004','February 2004','February 2006'))
group by
 TIME_.MONTH_NAME, PRODUCT.PRODUCT_NAME
```

Multiple-fact, Multiple-grain Query on Non-Conformed Dimensions

If a non-conformed dimension is added to the query, the nature of the result returned by the stitched query is changed. It is no longer possible to aggregate records to a lowest common level of granularity because one side of the query has dimensionality that is not common to the other side of the query. The result returned is really two correlated lists.



The Result

The results of individual queries on the respective star schemas look like this.

MONTH_NAME	PRODUCT_NAME	ORDER_METHOD	QUANTITY
April 2004	Aloe Relief	E-mail	114
April 2004	Aloe Relief	Fax	220
April 2004	Aloe Relief	Mail	100
April 2004	Aloe Relief	Sales visit	322
April 2004	Aloe Relief	Telephone	286
April 2004	Aloe Relief	Web	368
April 2004	Course Pro Umbrella	E-mail	22
April 2004	Course Pro Umbrella	Fax	28
April 2004	Course Pro Umbrella	Sales visit	82
February 2004	Aloe Relief	Mail	28
February 2004	Aloe Relief	Sales visit	102
February 2004	Aloe Relief	Telephone	28
February 2004	Aloe Relief	Web	112
February 2006	Aloe Relief	Sales visit	88

MONTH_NAME	PRODUCT_NAME	QUANTITY	EXPECTED_VOLUME
April 2004	Aloe Relief	1,410	1,690
April 2004	Course Pro Umbrella	132	125
February 2004	Aloe Relief	270	246
February 2004	Course Pro Umbrella		1
February 2006	Aloe Relief	88	92

Querying the same items from both star schemas yields the following result.

MONTH_NAME	PRODUCT_NAME	ORDER_METHOD	QUANTITY	EXPECTED_VOLUME
April 2004	Aloe Relief	Sales visit	322	1,690
April 2004	Aloe Relief	Telephone	286	1,690
April 2004	Aloe Relief	Web	368	1,690
April 2004	Aloe Relief	E-mail	114	1,690
April 2004	Aloe Relief	Fax	220	1,690
April 2004	Aloe Relief	Mail	100	1,690
April 2004	Course Pro Umbrella	E-mail	22	125
April 2004	Course Pro Umbrella	Fax	28	125
April 2004	Course Pro Umbrella	Sales visit	82	125
February 2004	Aloe Relief	Web	112	246
February 2004	Aloe Relief	Mail	28	246
February 2004	Aloe Relief	Sales visit	102	246
February 2004	Aloe Relief	Telephone	28	246
February 2004	Course Pro Umbrella			1
February 2006	Aloe Relief	Sales visit	88	92

In this result, the lower level of granularity for records from Sales results in more records being returned for each month and product combination. There is now a 1-n relationship between the rows returned from Product Forecast and those returned from Sales.

When you compare this to the result returned in the example of the multiple-fact, multiple grain query on conformed dimensions, you can see that more records are returned and that Expected Volume results are repeated across multiple Order Methods. Adding Order Method to the query effectively changes the relationship between Quantity data and Expected Volume data to a 1-n relationship. It is no longer possible to relate a single value from Expected Volume to one value from Quantity.

Grouping on the Month key demonstrates that the result in this example is based on the same data set as the result in the multiple-fact, multiple-grain query but with a greater degree of granularity.

The SQL

The stitched SQL generated for this example is very similar to the SQL generated in the multiple-fact, multiple-grain query. The main difference is the addition of Order Method. Order Method is not a conformed dimension and affects only the query against the Sales Fact table.

```
select
 D2.QUANTITY as QUANTITY,
 D3.EXPECTED_VOLUME as EXPECTED_VOLUME,
 coalesce(D2.PRODUCT_NAME,D3.PRODUCT_NAME) as PRODUCT_NAME,
 coalesce(D2.MONTH_NAME,D3.MONTH_NAME) as MONTH_NAME,
 D2.ORDER_METHOD as ORDER_METHOD
from
 (select
 PRODUCT.PRODUCT_NAME as PRODUCT_NAME,
 TIME.MONTH_NAME as MONTH_NAME,
 ORDER_METHOD.ORDER_METHOD as ORDER_METHOD,
 XSUM(SALES_FACT.QUANTITY for TIME.CURRENT_YEAR,TIME.QUARTER_KEY,
 TIME.MONTH_KEY,PRODUCT.PRODUCT_LINE_CODE,PRODUCT.PRODUCT_TYPE_CODE,
 PRODUCT.PRODUCT_KEY,ORDER_METHOD_DIMENSION.ORDER_METHOD_KEY) as
QUANTITY
from
 PRODUCT_DIMENSION PRODUCT
 join
 SALES_FACT SALES_FACT
 on (PRODUCT.PRODUCT_KEY = SALES_FACT.PRODUCT_KEY)
 join
 ORDER_METHOD_DIMENSION ORDER_METHOD
 on (ORDER_METHOD.ORDER_METHOD_KEY = SALES_FACT.ORDER_METHOD_KEY)
 join TIME_DIMENSION TIME
 on ( TIME.DAY_KEY = SALES_FACT.ORDER_DAY_KEY)
where
 (PRODUCT.PRODUCT_NAME in ('Aloe Relief','Course Pro Umbrella'))
and
 ( TIME.MONTH_NAME in ('April 2004','February 2004','February 2006'))
 group by
 PRODUCT.PRODUCT_NAME,
 TIME.MONTH_NAME,
 ORDER_METHOD.ORDER_METHOD
 ) D2
 full outer join
(select
 PRODUCT.PRODUCT_NAME as PRODUCT_NAME,
 TIME.MONTH_NAME as MONTH_NAME,
 XSUM(PRODUCT_FORECAST_FACT.EXPECTED_VOLUME for TIME.CURRENT_YEAR,
 TIME.QUARTER_KEY,TIME.MONTH_KEY,PRODUCT.PRODUCT_LINE_CODE,
 PRODUCT.PRODUCT_TYPE_CODE,PRODUCT.PRODUCT_KEY) as EXPECTED_VOLUME
from
 PRODUCT_DIMENSION PRODUCT
 join
 PRODUCT_FORECAST_FACT PRODUCT_FORECAST_FACT
 on (PRODUCT.PRODUCT_KEY = PRODUCT_FORECAST_FACT.PRODUCT_KEY)
 join
(select
 TIME.CURRENT_YEAR as CURRENT_YEAR,
 TIME.QUARTER_KEY as QUARTER_KEY,
 TIME.MONTH_KEY as MONTH_KEY,
 XMIN(TIME.MONTH_NAME for TIME.CURRENT_YEAR, TIME.QUARTER_KEY,
 TIME.MONTH_KEY) as MONTH_NAME
from
 TIME_DIMENSION TIME
group by
 TIME.CURRENT_YEAR,
 TIME.QUARTER_KEY,
 TIME.MONTH_KEY
 ) TIME
```

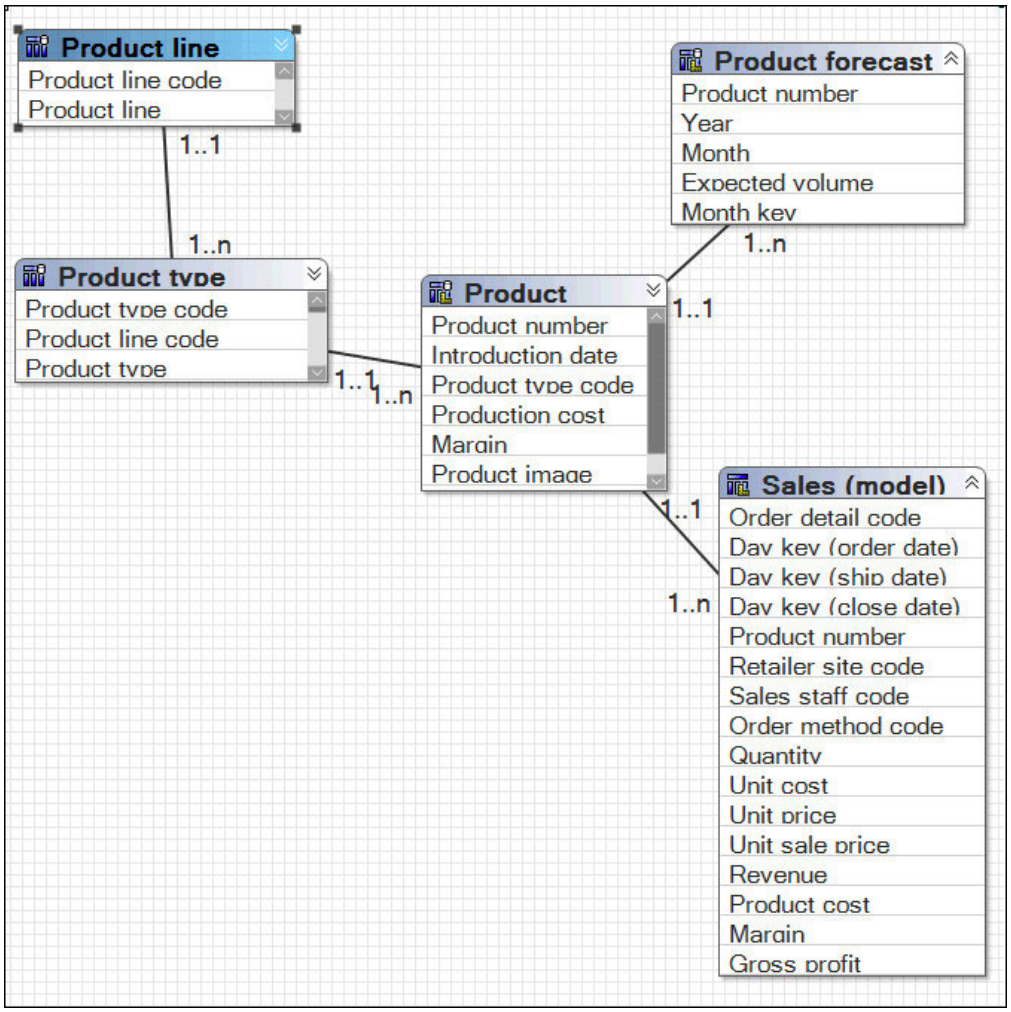
```
 on (TIME.MONTH_KEY = PRODUCT_FORECAST_FACT.MONTH_KEY)
where
 (PRODUCT.PRODUCT_NAME in ('Aloe Relief','Course Pro Umbrella'))
and
 (TIME.MONTH_NAME in ('April 2004','February 2004','February 2006'))
 group by
 PRODUCT.PRODUCT_NAME,
 TIME.MONTH_NAME
 ) D3
 on ((D2.PRODUCT_NAME = D3.PRODUCT_NAME) and
 (D2.MONTH_NAME = D3.MONTH_NAME))
```

Resolving Ambiguously Identified Dimensions and Facts

A query subject is considered to be ambiguously defined if it participates in both n and 1 relationships to other query subjects. An ambiguously defined query subject is not always harmful from a query generation perspective. We suggest that you evaluate query subjects using the following cases. The goal of this evaluation is to prevent unnecessary query splits and to ensure that any splits that do occur are intentional and correct.

Query Subjects That Represent a Level of Hierarchy

One frequent case of an ambiguously defined query subject that is not harmful is where the query subject represents an intermediate level of a descriptive hierarchy. One example is the following Product hierarchy.



In this example, both Product type and Product could be identified as being ambiguously defined. However, this ambiguity is not detrimental to either the results generated or the performance of any query using one or more of these query subjects. You do not need to fix this query pattern because, using the rules for fact detection, only one fact is identified in any query that combines an item from the Product forecast or Sales query subjects. It remains a best practice to collapse hierarchies into a single regular dimension when modeling for analysis purposes.

Some queries that can be written using this example include the following:

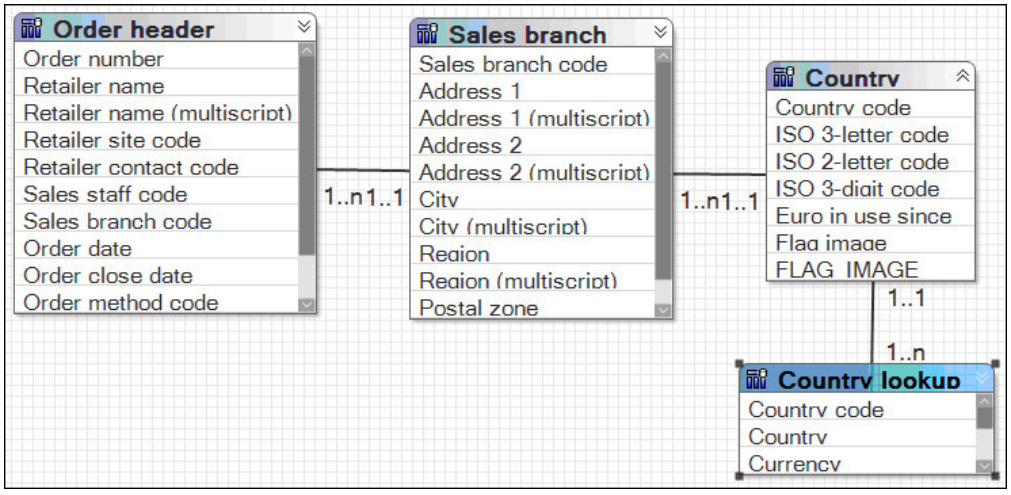
Items from these query subjects are used in a query:	**Query subject that behaves as a fact in the query:**
Product line and Product type	Product type
Product line, Product type, and Product	Product
Product line, Product type, Product, and Sales	Sales
Product line and Sales	Sales
Product type and Product forecast	Product forecast

Resolving Queries That Should Not Have Been Split

If queries are split and should not be split, you must resolve these queries.

Query subjects on the `n` side of all relationships are identified as facts. We can see that in the following example, Order Header and Country Multilingual are behaving as facts. In reality, the Country Multilingual query subject contains only descriptive information and seems to be a lookup table. From a dimensional or business modeling perspective, Country Multilingual is an extension of Country.

Why is it a problem to leave the model like this?



Test this model by authoring a report on the number of orders per city, per country or region. Using this model returns an incorrect result. The numbers are correct for the cities but some cities are shown as being in the wrong country or region. This is an example of an incorrectly related result.

COUNTRY	CITY	Number of Orders
Australia	Amsterdam	279
Austria	Bilbao	123
Belgium	Birmingham	164
Brazil	Boston	515
Canada	Calgary	123

Usually the first place to look when you see something like this is in the SQL.

The SQL

In this example, we see a stitched query, which makes sense if we have multiple facts in the model. A stitched query is essentially a query that attempts to stitch multiple facts together. It uses the relationships that relate the facts to each other as well as the determinants for the conformed, or common, dimensions defined in the model. A stitched query can be identified by two queries with a full outer join. The wrapper query must include a `coalesce` statement on the conformed dimensions.

Note the following problems in the SQL:

- The query has no `coalesce` statement.

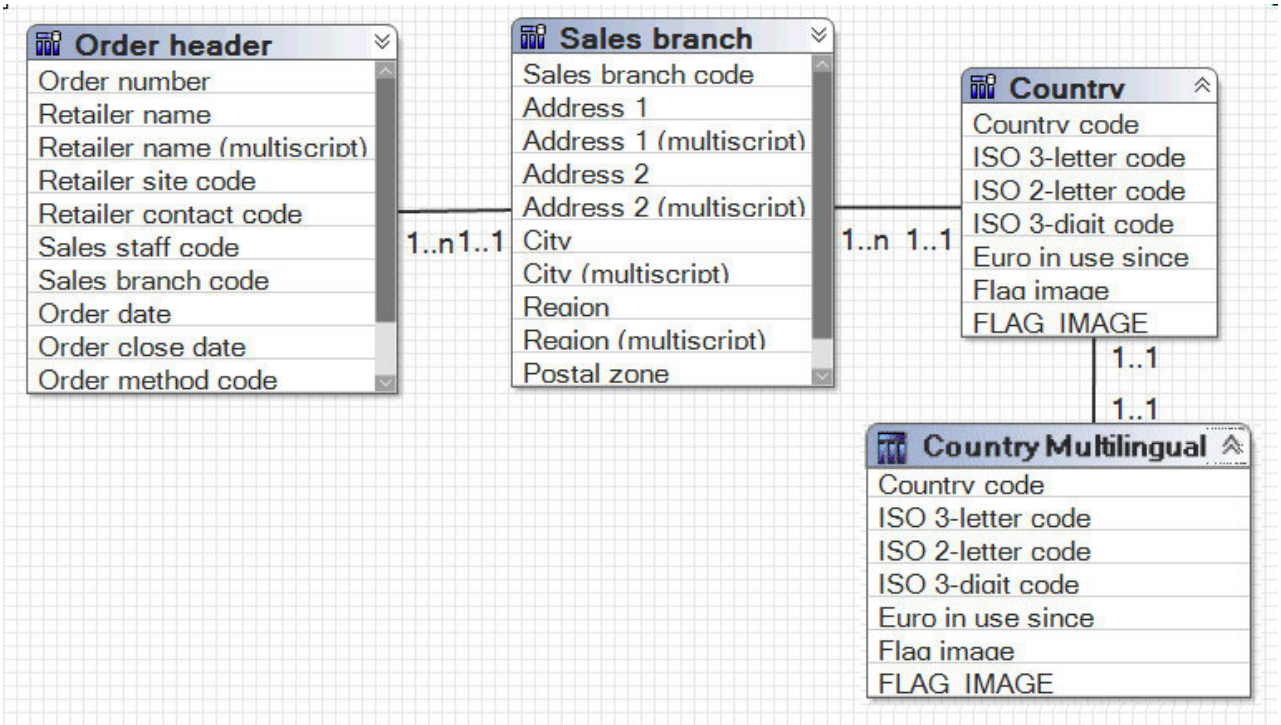
- RSUM indicates an attempt to create a valid key.

```
select
 D3.COUNTRY as COUNTRY,
 D2.CITY as CITY,
 D2.number_of_orders as number_of_orders
from
(select
 SALES_BRANCH.CITY as CITY,
 XCOUNT(ORDER_HEADER.ORDER_NUMBER for SALES_BRANCH.CITY) as
 number_of_orders,
 RSUM(1 at SALES_BRANCH.CITY order by SALES_BRANCH.CITY
asc local)
 as sc
 from
 gosales.gosales.dbo.SALES_BRANCH SALES_BRANCH
 join
 gosales.gosales.dbo.ORDER_HEADER ORDER_HEADER
 on (SALES_BRANCH.SALES_BRANCH_CODE = ORDER_HEADER.SALES_BRANCH_CODE)
group by
 SALES_BRANCH.CITY
order by
 CITY asc
 ) D2
full outer join
(select
 COUNTRY_MULTILINGUAL.COUNTRY as COUNTRY,
 RSUM(1 at COUNTRY_MULTILINGUAL.COUNTRY order by
 COUNTRY_MULTILINGUAL.COUNTRY asc local) as sc
from
 gosales.gosales.dbo.COUNTRY_MULTILINGUAL COUNTRY_MULTILINGUAL
group by
 COUNTRY_MULTILINGUAL.COUNTRY
order by
 COUNTRY asc
 ) D3
 on (D2.sc = D3.sc)
```

By looking at the stitched columns in each query, we see that they are being calculated on unrelated criteria. This explains why there is no apparent relationship between the countries or regions and cities in the report.

So why do we see a stitched query? To answer that question, we must look at the model.

In this example, the query items used in the report came from different query subjects. Country or region came from Country Multilingual, City came from Sales Branch, and the Number of Orders came from a count on Order Number in the Order Header query subject.



The problem is that the query splits because the query engine sees this as a multiple-fact query. However, the split does not have a valid key on which to stitch because there is no item that both facts have in common.

There is more than one way to solve this problem but both require understanding the data.

Solution 1

You can add a filter to Country Multilingual that changes the cardinality of the relationship to 1-1.

```
Select *
from [GOSL].COUNTRY_MULTILINGUAL
Where
COUNTRY_MULTILINGUAL."LANGUAGE"='EN'
```

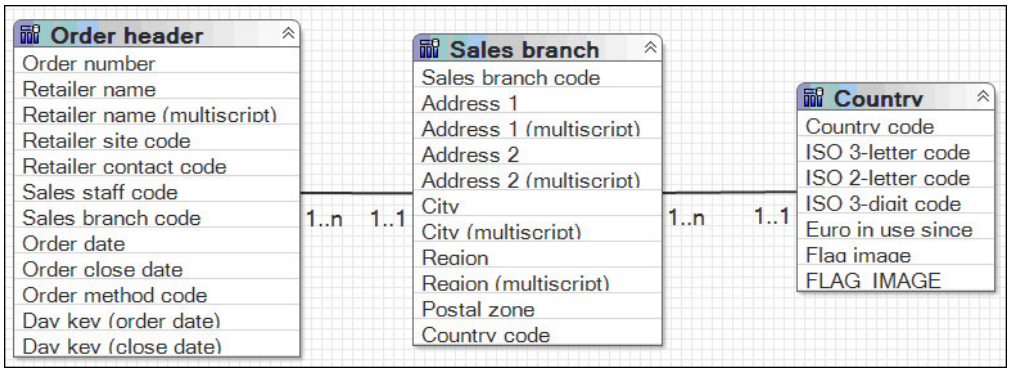
Or you can add a filter on the relationship and change the cardinality to 1-1.

```
COUNTRY.COUNTRY_CODE = COUNTRY_MULTILINGUAL.COUNTRY_CODE
and COUNTRY_MULTILINGUAL.LANGUAGE = 'EN'
```

Either choice results in a model that has a single fact in this query.

Solution 2

Simplify the model by consolidating the related query subjects. This gives the greatest benefit by simplifying the model and reducing the opportunities for error in query generation.



With either solution, the result of the query is now correct.

COUNTRY	CITY	Number of Orders
Australia	Melbourne	98
Austria	Wien	162
Belgium	Heverlee	94
Brazil	São Paulo	15
Canada	Calgary	123
Canada	Toronto	330

The SQL is no longer a stitched query.

```
select
 Country.c7 as COUNTRY,
 SALES_BRANCH.CITY as CITY,
 XCOUNT(ORDER_HEADER.ORDER_NUMBER for Country.c7,SALES_BRANCH.CITY)
 as number_of_orders
from
(select
 COUNTRY.COUNTRY_CODE as c1,
 COUNTRY_MULTILINGUAL.COUNTRY as c7
from
 gosales.gosales.dbo.COUNTRY COUNTRY
 join
 gosales.gosales.dbo.COUNTRY_MULTILINGUAL COUNTRY_MULTILINGUAL
 on (COUNTRY.COUNTRY_CODE = COUNTRY_MULTILINGUAL.COUNTRY_CODE)
 where COUNTRY_MULTILINGUAL.LANGUAGE='EN'
 ) Country
join
 gosales.gosales.dbo.SALES_BRANCH SALES_BRANCH
 on (SALES_BRANCH.COUNTRY_CODE = Country.c1)
 join
 gosales.gosales.dbo.ORDER_HEADER ORDER_HEADER
 on (SALES_BRANCH.SALES_BRANCH_CODE = ORDER_HEADER.SALES_BRANCH_CODE)
group by
 Country.c7,
 SALES_BRANCH.CITY
```

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