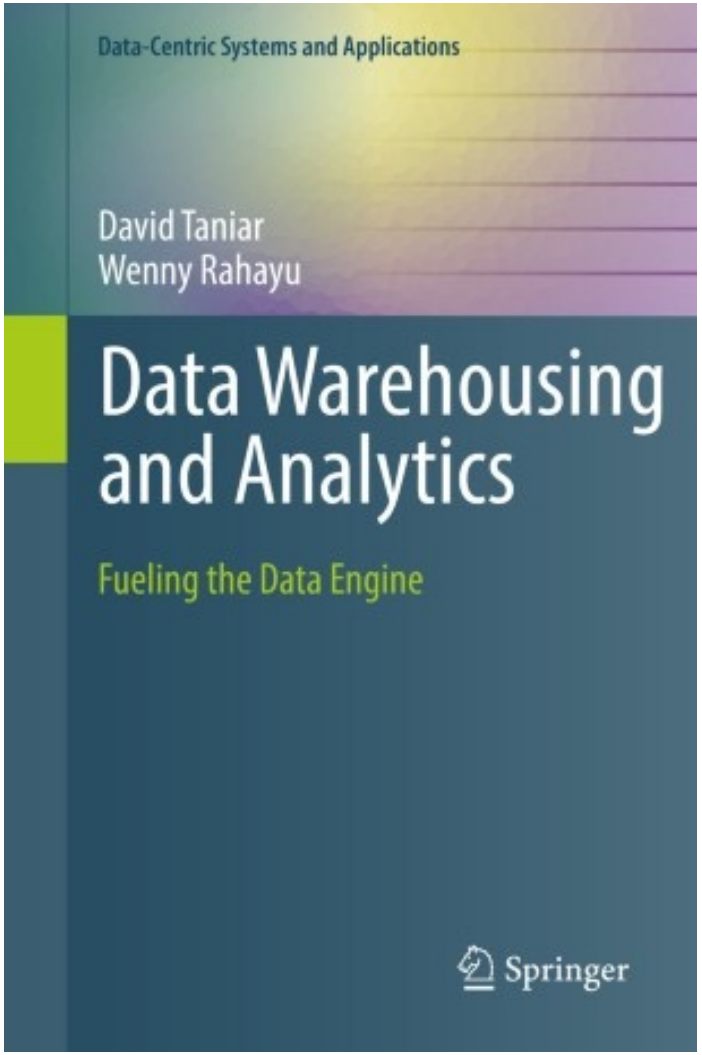
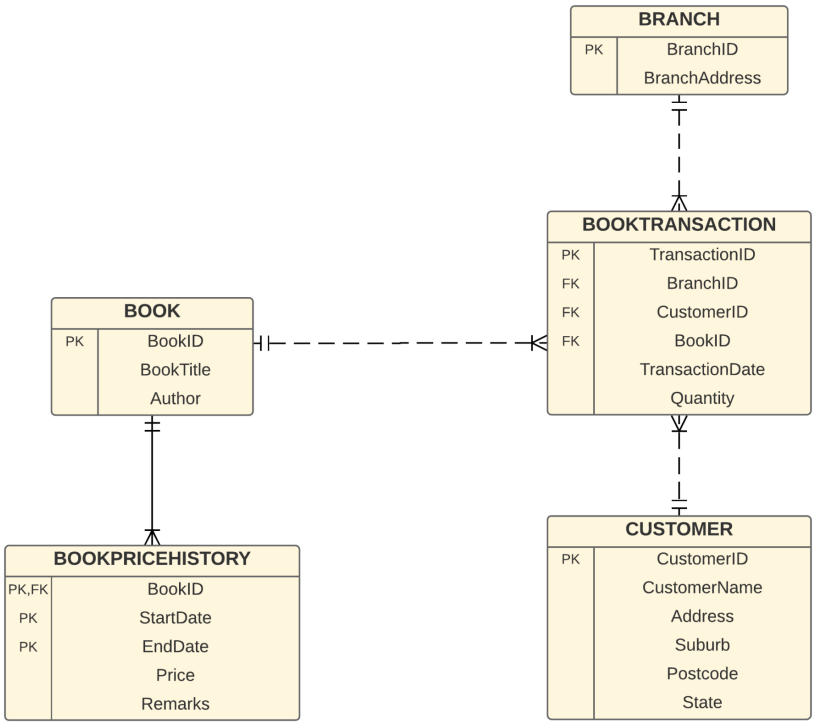
# Chapter 6
# Temporal Data Warehousing



# Overview

- A warehousing technique whereby the temporal (or historical) aspect of records is incorporated into the data warehouse
- *Slowly Changing Dimensions* (*SCD*)

# 1. A Bookshop Case Study




- All book sales transactions are stored in an operational database
- Need to analyse book sales performance from various perspectives:
  - monthly basis
  - book basis
  - branch basis

# 1. A Bookshop Case Study

## A Simple Star Schema

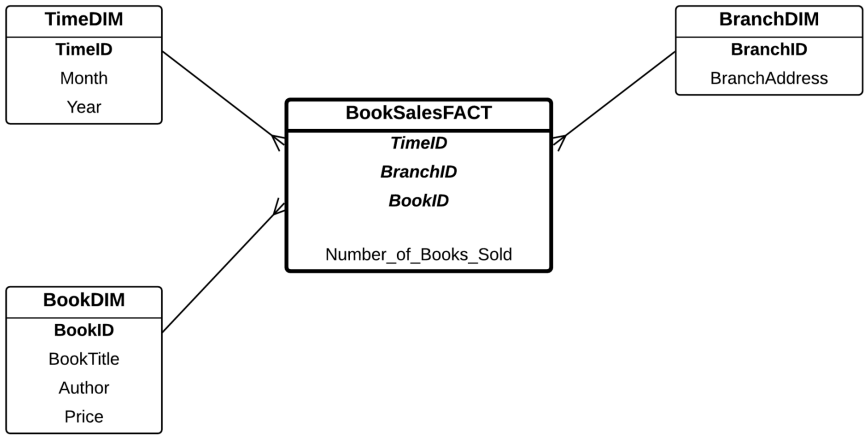



**Table 6.1** BookSalesFact Table

| TimeID | BranchID | BookID | Number of books sold |
|---|---|---|---|
| Mar2008 | City | C1 | 5 |
| Mar2008 | City | H6 | 15 |
| Mar2008 | City | DV | 23 |
| Mar2008 | City | ... | ... |
| Mar2008 | Chadstone | C1 | 15 |
| Mar2008 | Chadstone | H6 | 3 |
| Mar2008 | Chadstone | DV | 2 |
| Mar2008 | Chadstone | ... | ... |
| Mar2008 | Camberwell | C1 | 1 |
| Mar2008 | Camberwell | H6 | 1 |
| Mar2008 | Camberwell | DV | 2 |
| Mar2008 | Camberwell | ... | ... |
| Mar2008 | ... | ... | ... |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Dec2007 | City | C1 | 15 |
| Dec2007 | City | H6 | 6 |
| Dec2007 | City | DV | 6 |
| Dec2007 | City | ... | ... |
| Dec2007 | Chadstone | C1 | 10 |
| Dec2007 | Chadstone | H6 | 8 |
| Dec2007 | Chadstone | DV | 1 |
| Dec2007 | Chadstone | ... | ... |
| Dec2007 | Camberwell | C1 | 18 |
| Dec2007 | Camberwell | H6 | 3 |
| Dec2007 | Camberwell | DV | 2 |
| Dec2007 | Camberwell | ... | ... |
| Dec2007 | ... | ... | ... |
| ... | ... | ... | ... |

**Table 6.2** Book Dimension table

| BookID | Book title | Author | Price |
|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | $45.95 |
| H6 | Harry Potter 6 | Rowling | $30.95 |
| DV | Da Vinci Code | Dan Brown | $27.95 |
| ... | ... | ... | ... |

# 1. A Bookshop Case Study

## A Simple Star Schema

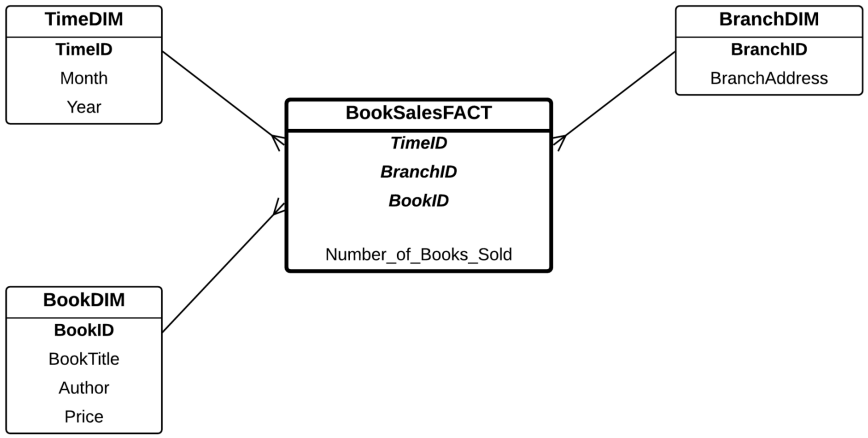



**Table 6.3** Report 1 (Book Sales Fact with Book Dimension)

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 15 |
| Mar2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Mar2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 1 |
| Mar2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | .. | ... | ... | ... | ... | ... |
| Dec2007 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Dec2007 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 10 |
| Dec2007 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 18 |
| Dec2007 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | .. | ... | ... | ... | ... | ... |

# 1. A Bookshop Case Study

- Why C1 had more sales on Dec 2007?
- Price does not reflect actual selling prices
- Price column contains the *Current Price* of each book
- From time to time, price may change → temporal values

**Table 6.3** Report 1 (Book Sales Fact with Book Dimension)

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 15 |
| Mar2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Mar2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 1 |
| Mar2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | .. | ... | ... | ... | ... | ... |
| Dec2007 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Dec2007 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 10 |
| Dec2007 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 18 |
| Dec2007 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | .. | ... | ... | ... | ... | ... |

# 1. A Bookshop Case Study

- Bridge Table to the Book Dimension, to store the history of book prices

**Table 6.4** Book Dimension table

| BookID | Book title | Author |
|---|---|---|
| C1 | CSIRO Diet | CSIRO Team |
| H6 | Harry Potter 6 | Rowling |
| DV | Da Vinci Code | Dan Brown |
| ... | ... | ... |

**Table 6.5** Book Price Dimension table

| BookID | Start date | End date | Price | Remarks |
|---|---|---|---|---|
| C1 | Jan2007 | July2007 | $45.95 | Full Price |
| C1 | Aug2007 | Oct2007 | $36.75 | 20% Discount |
| C1 | Nov2007 | Jan2008 | $23.00 | Half Price |
| C1 | Feb2008 | **Dec9999** | $45.95 | Full Price |
| H6 | Jan2007 | Mar2007 | $21.95 | Launching |
| H6 | Apr2007 | Jan2008 | $30.95 | Full Price |
| H6 | Feb2008 | **Dec9999** | $10.00 | End of Product Sale |
| DV | Jan2007 | **Dec9999** | $27.95 | Full Price |
| ... | ... | ... | ... | ... |

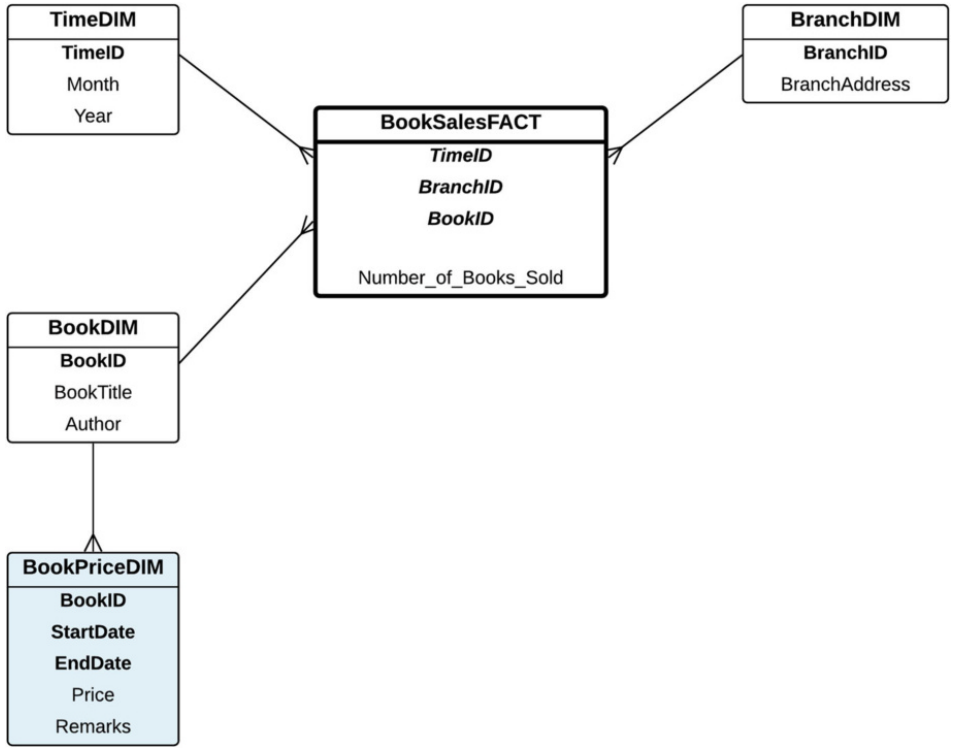



**Fig. 6.2** A temporal data warehousing star schema

# 1. A Bookshop Case Study

**Table 6.4** Book Dimension table

| BookID | Book title | Author |
|---|---|---|
| C1 | CSIRO Diet | CSIRO Team |
| H6 | Harry Potter 6 | Rowling |
| DV | Da Vinci Code | Dan Brown |
| ... | ... | ... |

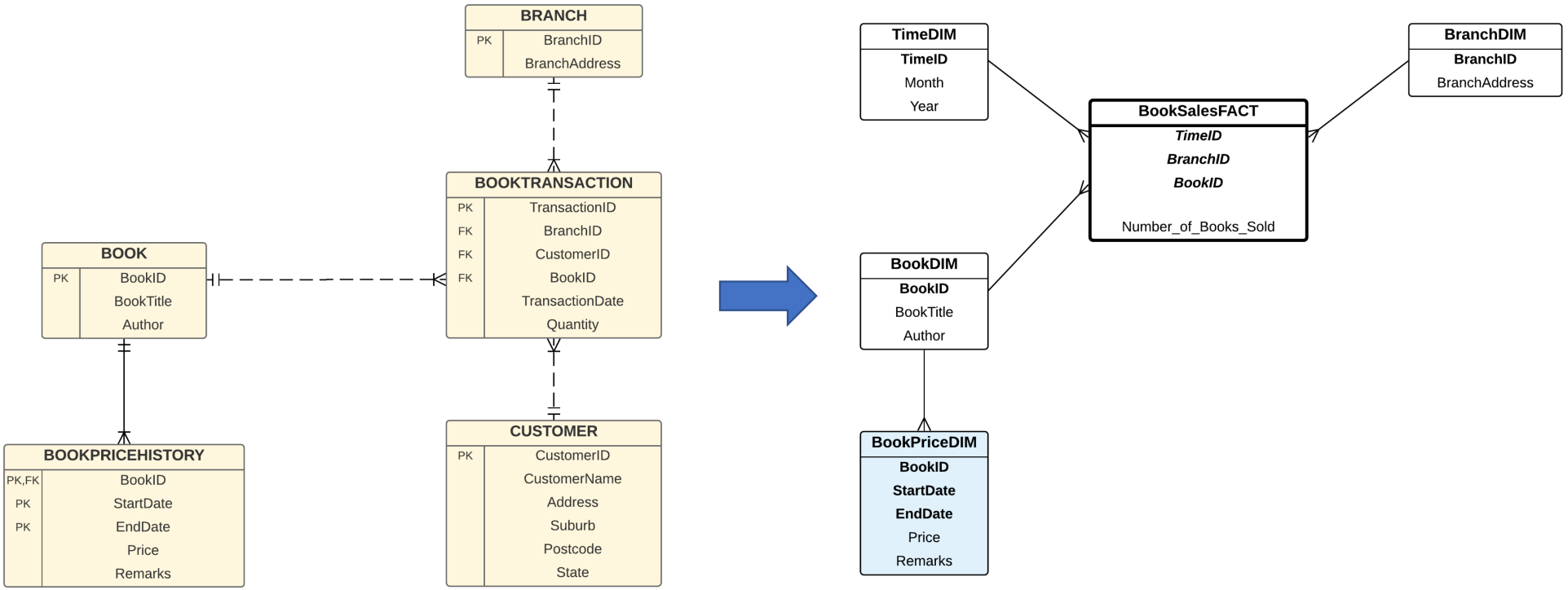
**Table 6.5** Book Price Dimension table

| BookID | Start date | End date | Price | Remarks |
|---|---|---|---|---|
| C1 | Jan2007 | July2007 | $45.95 | Full Price |
| C1 | Aug2007 | Oct2007 | $36.75 | 20% Discount |
| C1 | Nov2007 | Jan2008 | $23.00 | Half Price |
| C1 | Feb2008 | **Dec9999** | $45.95 | Full Price |
| H6 | Jan2007 | Mar2007 | $21.95 | Launching |
| H6 | Apr2007 | Jan2008 | $30.95 | Full Price |
| H6 | Feb2008 | **Dec9999** | $10.00 | End of Product Sale |
| DV | Jan2007 | **Dec9999** | $27.95 | Full Price |
| ... | ... | ... | ... | ... |

**Table 6.6** Report 2 with the correct Book Price

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | H6 | Harry Potter 6 | Rowling | **$10.00** | 15 |
| Mar2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | H6 | Harry Potter 6 | Rowling | **$10.00** | 3 |
| Mar2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | H6 | Harry Potter 6 | Rowling | **$10.00** | 1 |
| Mar2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| Dec2007 | City | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 15 |
| Dec2007 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 10 |
| Dec2007 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 18 |
| Dec2007 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

# 2. Implementation of Temporal Data Warehousing



# 2. Implementation of Temporal Data Warehousing

```
create table BranchDim as
select * from Branch;

create table BookDim as
select * from Book;

create table TimeDim as
select distinct
  to_char(TransactionDate, 'MonYYYY') as TimeID,
  to_char(TransactionDate, 'Mon') as Month,
  to_char(TransactionDate, 'YYYY') as Year
from BookTransaction;

create table BookPriceDim as
select  * from BookPriceHistory;
```

```
create table BookSalesFact1 as
select
  to_char(T.TransactionDate, 'MonYYYY') as TimeID,
  BK.BookID,
  BR.BranchID,
  sum(T.Quantity) as Number_of_Books_Sold
from BookTransaction T, Book BK, Branch BR
where T.BranchID = BR.BranchID
and T.BookID = BK.BookID
group by
  to_char(T.TransactionDate, 'MonYYYY'),
  BK.BookID,
  BR.BranchID;
```

# 2 Implementation of Temporal Data Warehousing

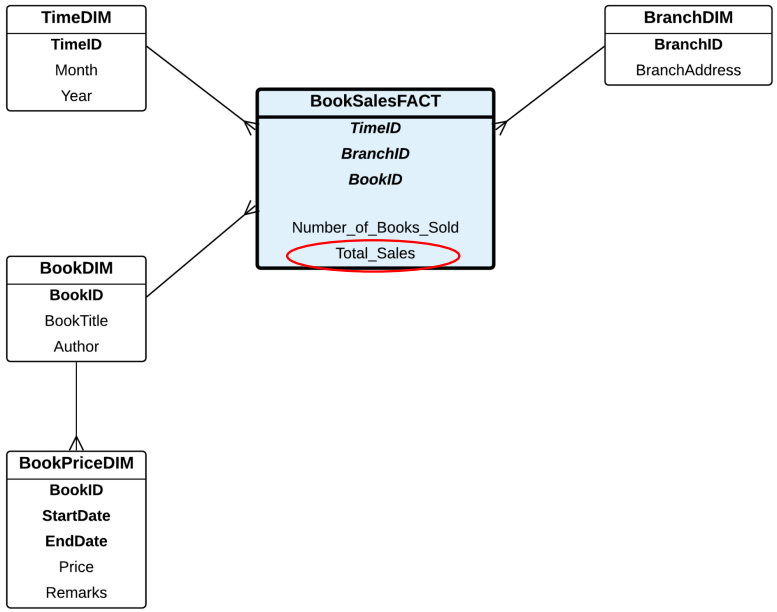
**Table 1.6** Report 2 with the correct Book Price

| TimeID | BranchID | BookID | Book Title | Author | Price | Number of Books Sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | H6 | Harry Potter 6 | Rowling | **$10.00** | 15 |
| Mar2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | H6 | Harry Potter 6 | Rowling | **$10.00** | 3 |
| Mar2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | H6 | Harry Potter 6 | Rowling | **$10.00** | 1 |
| Mar2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| Dec2007 | City | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 15 |
| Dec2007 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 10 |
| Dec2007 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 18 |
| Dec2007 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

- More sales on Dec 2007 was due to discount price

# 2. Implementation of Temporal Data Warehousing

A new fact attribute: Total Sales




- A new additional fact measure is added → *Total Sales*
- Assumes that BookSalesFact1 has been created

# 2. Implementation of Temporal Data Warehousing

```
create table BookSalesFact2 as
select * from BookSalesFact1;

alter table BookSalesFact2
add (Total_Sales number);

declare
  cursor PriceCursor is
    select *
    from BookPriceDim;
begin
  for Item in PriceCursor loop
    -- update value for Total_Sales in BookSalesFact2
    update BookSalesFact2
    set Total_Sales = Number_Of_Books_Sold * Item.Price
    where BookID = Item.BookID
    and to_date(TimeID, 'MonYYYY') >=
      to_date(Item.StartDate, 'MonYYYY')
    and to_date(TimeID, 'MonYYYY') <=
      to_date(Item.EndDate, 'MonYYYY');
  end loop;
end;
/
```

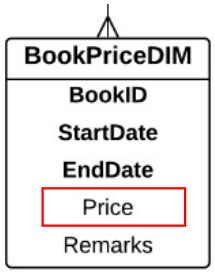
```
create table BookSalesFact2 as
select
    to_char(T.TransactionDate, 'MonYYYY') as TimeID,
    BK.BookID,
    BR.BranchID,
    sum(T.Quantity) as Number_Of_Books_Sold,
    sum(T.Quantity * BP.Price) as Total_Sales
from
    BookTransaction T,
    Book BK,
    Branch BR,
    BookPriceHistory BP
where T.BranchID = BR.BranchID
and T.BookID = BK.BookID
and BK.BookID = BP.BookID
and T.TransactionDate >= to_date(BP.StartDate, 'MonYYYY')
and T.TransactionDate <= to_date(BP.EndDate, 'MonYYYY')
group by
    to_char(T.TransactionDate, 'MonYYYY'),
    BK.BookID,
    BR.BranchID;
```

# 3. Temporal Attributes and Temporal Dimensions

- **Temporal attribute**
  An attribute in which the value of that attribute has a life-time
- **Temporal Dimension**
  A dimension where the record of the dimension has a life-time

# 3.1. Temporal Attributes

- An attribute in which the value of that attribute has a life-time
- Each book price has a life-time, and the life-time is determined by the Start Date and End Date attributes in the Book Price Dimension table
- Example:
  The book price of $45.95 of Book C1 is only valid between Jan-2007 and July-2007.



# 3.1. Temporal Attributes

## SQL to produce the report

```
select
  F.TimeID,
  F.BranchID,
  F.BookID,
  B.BookTitle,
  B.Author,
  P.Price,
  F.Number_of_Books_Sold
from BookSalesFact F, BookDim B, BookPriceDim P
where F.BookID = B.BookID
and B.BookID = P.BookID
and to_date(F.TimeID, 'MonYYYY') >=
  to_date(P.StartDate, 'MonYYYY')
and to_date(F.TimeID, 'MonYYYY') <=
  to_date(P.EndDate, 'MonYYYY');
```

**Table 6.6** Report 2 with the correct Book Price

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | C1 | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | H6 | Harry Potter 6 | Rowling | **$10.00** | 15 |
| Mar2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | H6 | Harry Potter 6 | Rowling | **$10.00** | 3 |
| Mar2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | H6 | Harry Potter 6 | Rowling | **$10.00** | 1 |
| Mar2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| Dec2007 | City | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 15 |
| Dec2007 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 10 |
| Dec2007 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | C1 | CSIRO Diet | CSIRO Team | **$23.00** | 18 |
| Dec2007 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

# 3.1. Temporal Attributes

- Problem:
  - Granularity between book price and fact is different

```
and to_date(F.TimeID, 'MonYYYY') >=
  to_date(P.StartDate, 'MonYYYY')
and to_date(F.TimeID, 'MonYYYY') <=
  to_date(P.EndDate, 'MonYYYY');
```

**Table 6.7** BookPriceDim table

| BookID | Start date | End date | Price | Remarks |
|---|---|---|---|---|
| C1 | Jan2007 | Jul2007 | $45.95 | Full Price |
| C1 | Aug2007 | Oct2007 | $36.75 | 20% Discount |
| C1 | Nov2007 | **15Jan2008** | $23.00 | Half Price |
| C1 | **16Jan2008** | Dec9999 | $45.95 | Full Price |
| H6 | Jan2007 | Mar2007 | $21.95 | Launching |
| H6 | Apr2007 | Jan2008 | $30.95 | Full Price |
| H6 | Feb2008 | Dec9999 | $10.00 | End of Product Sale |
| DV | Jan2007 | Dec9999 | $27.95 | Full Price |
| ... | ... | ... | ... | ... |

**Table 6.8** Report 3: an incorrect report

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| **Jan2008** | **City** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$23.00** | **25** |
| **Jan2008** | **City** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$45.95** | **25** |
| Jan2008 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 10 |
| Jan2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 7 |
| Jan2008 | City | ... | ... | ... | ... | ... |
| **Jan2008** | **Chadstone** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$23.00** | **30** |
| **Jan2008** | **Chadstone** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$45.05** | **30** |
| Jan2008 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 15 |
| Jan2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 5 |
| Jan2008 | Chadstone | ... | ... | ... | ... | ... |
| **Jan2008** | **Camberwell** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$23.00** | **20** |
| **Jan2008** | **Camberwell** | **C1** | **CSIRO Diet** | **CSIRO Team** | **$45.05** | **20** |
| Jan2008 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 5 |
| Jan2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 5 |
| Jan2008 | Camberwell | ... | ... | ... | ... | ... |
| Jan2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

# 3.1. Temporal Attributes

## The correct report

```
select
   F.TimeID,
   F.BranchID,
   F.BookID,
   B.BookTitle.
   B.Author,
   listagg(P.Price, ';') within group (order by P.Price)
     as Price,
   F.Number_of_Books_Sold
from BookSalesFact F, BookDim B, BookPriceDim P
where F.BookID = B.BookID
and B.BookID = P.BookID
and to_date(F.TimeID, 'MonYYYY') >=
  to_date(P.StartDate, 'MonYYYY')
and to_date(F.TimeID, 'MonYYYY') <=
  to_date(P.EndDate, 'MonYYYY')
group by
   F.TimeID,
   F.BranchID,
   F.BookID,
   B.BookTitle,
   B.Author,
   F.Number_of_Books_Sold;
```

**Table 6.9** Report 4: multiple book prices on one month

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books Sold |
|---|---|---|---|---|---|---|
| Jan2008 | City | C1 | CSIRO Diet | CSIRO Team | **$23.00;$45.95** | 25 |
| Jan2008 | City | H6 | Harry Potter 6 | Rowling | $30.95 | 10 |
| Jan2008 | City | DV | Da Vinci Code | Dan Brown | $27.95 | 7 |
| Jan2008 | City | ... | ... | ... | ... | ... |
| Jan2008 | Chadstone | C1 | CSIRO Diet | CSIRO Team | **$23.00;$45.95** | 30 |
| Jan2008 | Chadstone | H6 | Harry Potter 6 | Rowling | $30.95 | 15 |
| Jan2008 | Chadstone | DV | Da Vinci Code | Dan Brown | $27.95 | 5 |
| Jan2008 | Chadstone | ... | ... | ... | ... | ... |
| Jan2008 | Camberwell | C1 | CSIRO Diet | CSIRO Team | **$23.00;$45.95** | 20 |
| Jan2008 | Camberwell | H6 | Harry Potter 6 | Rowling | $30.95 | 5 |
| Jan2008 | Camberwell | DV | Da Vinci Code | Dan Brown | $27.95 | 5 |
| Jan2008 | Camberwell | ... | ... | ... | ... | ... |
| Jan2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

# 3.1. Temporal Attributes

```
create table BookSalesFact2 as
select
  to_char(T.TransactionDate, 'MonYYYY') as TimeID,
  BK.BookID,
  BR.BranchID,
  sum(T.Quantity) as Number_of_Books_Sold,
  sum(T.Quantity * BP.Price) as Total_Sales
from
  BookTransaction T,
  Book BK,
  Branch BR,
  BookPriceHistory BP
where T.BranchID = BR.BranchID
and T.BookID = BK.BookID
and BK.BookID = BP.BookID
and T.TransactionDate >= BP.StartDate
and T.TransactionDate <= BP.EndDate
group by
  to_char(T.TransactionDate, 'MonYYYY'),
  BK.BookID,
  BR.BranchID;
```

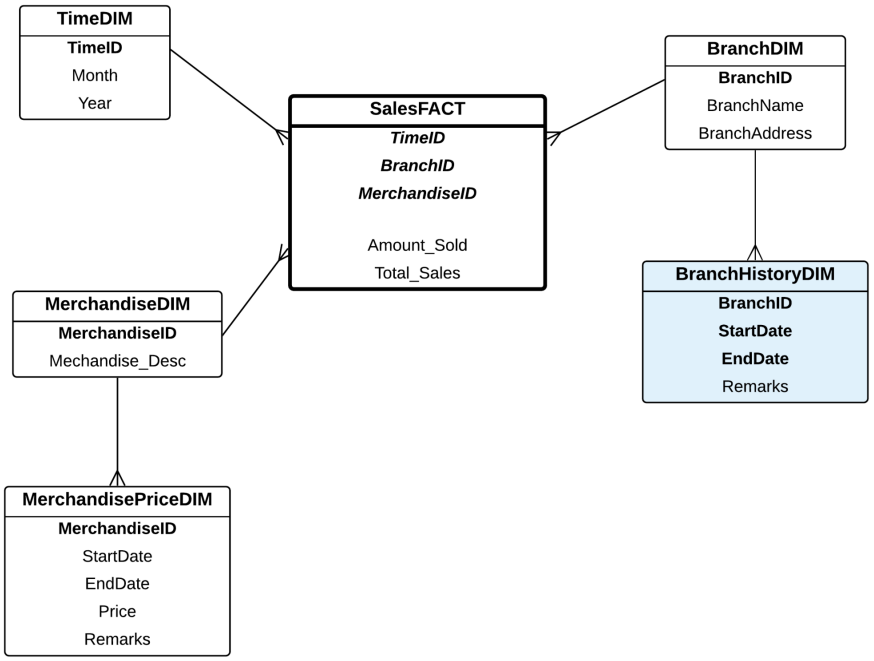
- The calculation for the Total Sales is still correct
- Assume that Start Date and End Date, as well as Transaction Date are of a date granularity

# 3.2. Temporal Dimensions

- A dimension where the record of the dimension has a life-time
- Example:
  - BookID C1 appeared in 2007, and disappeared in 2008, and then reappeared again in 2009
  - a branch opens and closes several times

# 3.2. Temporal Dimensions
# Calendar Shop Case

- Sales Analysis by dimensions:
  - Time
  - Branch
  - Merchandise
- Temporal Dimension:
  - Some branches have a certain life-time
  - Keep track the changes in prices for merchandise



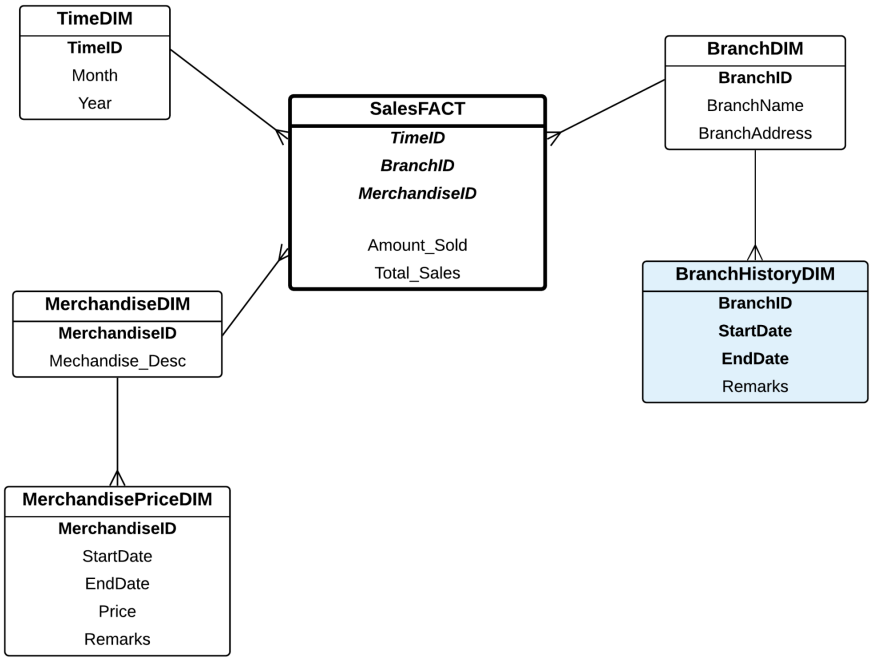
# 3.2. Temporal Dimensions
# Calendar Shop Case

**Table 6.10** Branch Dimension table

| BranchID | Branch name | Branch address |
|---|---|---|
| MEL | Melbourne Central | 88 Lonsdale St |
| CH | Chadstone Mall | 109 Dandenong Rd |
| DOW | Doncaster Westfield | 75 Doncaster Rd |
| ... | ... | ... |

**Table 6.11** BranchHistoryDim table

| BookID | Start date | End date | Remarks | Contact number |
|---|---|---|---|---|
| MEL | Jan0000 | Dec9999 | Main shop | (03) 9859 8070 |
| CH | Oct2007 | Mar2008 | | 0411 848 821 |
| CH | Oct2008 | Feb2009 | Under re-construction | 0413 356 665 |
| CH | Oct2009 | Feb2010 | | 0412 313 313 |
| DOW | Nov2007 | Feb2008 | | 0427 123 456 |
| DOW | Nov2008 | Feb2009 | | 0427 123 456 |
| DOW | Oct2009 | Feb2010 | | 0427 123 456 |
| ... | ... | ... | ... | ... |



# 3.2. Temporal Dimensions
# Calendar Shop Case

**Table 6.12** Report: SalesFact joined with Branch Dimension and Branch History Dimension

| Time ID | Branch ID | Branch name | Branch address | Start date | End date | Remarks | Contact number | Merchandise | Amount sold | Total sales |
|---|---|---|---|---|---|---|---|---|---|---|
| Oct2007 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... | ... | ... | ... |
| Oct2007 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ... | ... | ... | ... |
| Nov2007 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... | ... | ... | ... |
| Nov2007 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ...<br>... | ....<br>.... | ...<br>... | ...<br>... |
| Nov2007 | DOW | Doncaster Westfield | 75 Doncaster Road | Nov2007 | Feb2008 | | ...<br>... | . ...<br>. ... | ...<br>... | ...<br>... |
| Dec2007 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ...<br>... | ...<br>... | ...<br>... | ...<br>... |
| Dec2007 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ...<br>... | ....<br>.... | ...<br>... | ...<br>... |
| Dec2007 | DOW | Doncaster Westfield | 75 Doncaster Road | Nov2007 | Feb2008 | | ...<br>... | ....<br>.... | ...<br>... | ...<br>... |
| Jan2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ...<br>... | ...<br>... | ...<br>... | ...<br>... |
| Jan2008 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ...<br>... | ....<br>.... | ...<br>... | ...<br>... |
| Jan2008 | DOW | Doncaster Westfield | 75 Doncaster Road | Nov2007 | Feb2008 | | ...<br>... | ....<br>.... | ...<br>... | ...<br>... |

(continued)

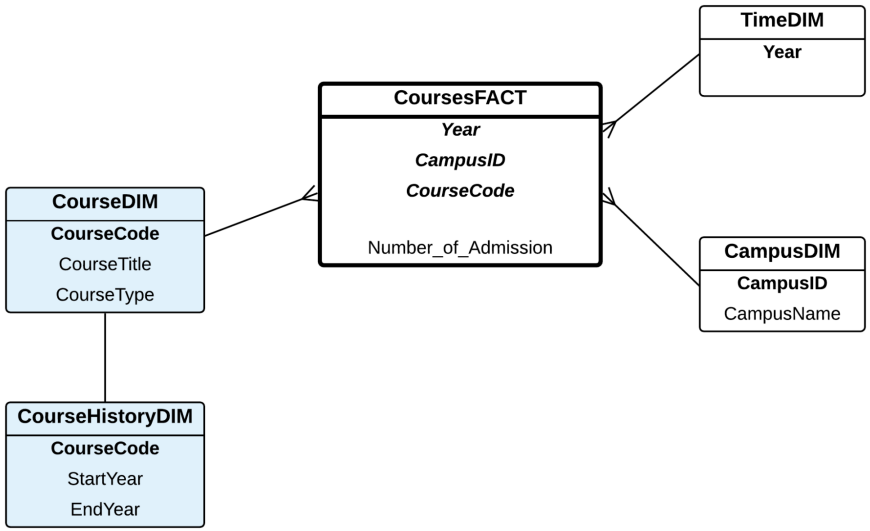
# 3.2. Temporal Dimensions
## Calendar Shop Case

**Table 6.12** (continued)

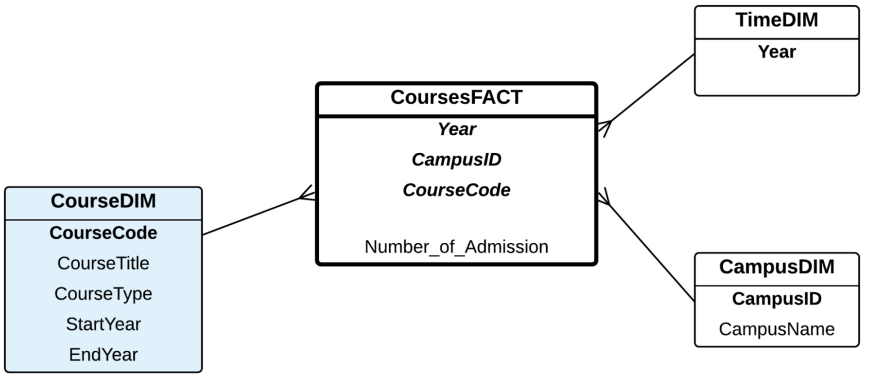
| Time ID | Branch ID | Branch name | Branch address | Start date | End date | Remarks | Contact number | Merchandise | Amount sold | Total sales |
|---|---|---|---|---|---|---|---|---|---|---|
| Feb2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... ... | ... ... | ... ... | ... ... |
| Feb2008 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ... ... | .... .... | ... ... | ... ... |
| Feb2008 | DOW | Doncaster Westfield | 75 Doncaster Road | Nov2007 | Feb2008 | | ... ... | .... .... | ... ... | ... ... |
| Mar2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... ... | ... ... | ... ... | ... ... |
| Mar2008 | CH | Chadstone Mall | 109 Dandenong Road | Oct2007 | Mar2008 | | ... ... | .... .... | ... ... | ... ... |
| Apr2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... ... | ... ... | ... ... | ... ... |
| May2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... ... | ... ... | ... ... | ... ... |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| Oct2008 | MEL | Melbourne Central | 88 Lonsdale Street | Jan0000 | Dec9999 | Main shop | ... ... | ... ... | ... ... | ... ... |
| Oct2008 | CH | Chadstone Mall | 109 Dandenong Road | Oct2008 | Feb2009 | Under re-construction | .... .... | ... ... | ... ... | ... ... |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

# 3.3. Another Temporal Dimension Courses/Degrees case

**Temporal Dimension – Using a Bridge Table**




**Temporal Dimension – Not as a Bridge Table**



# 4. Slowly Changing Dimensions (SCD)

- Temporal data warehousing = Slowly Changing Dimensions or SCD
- Dimensions where the records of these dimensions change slowly over a period of time
  - Not applicable to rapidly changed data
- Example:
  - The price of a book changes "slowly" over time
- Several SCD Types:
  - Original: Type 1, Type 2, Type 3
  - New Types: Type 0, Type 4, Type 6

# 4.1. SCD Type 0 and Type 1

**Type 0**

- Stores the "Original or Initial" value of the records

| BookID | Book Title | Author | Price |
|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | $45.95 |
| H6 | Harry Potter 6 | Rowling | $30.95 |
| DV | Da Vinci Code | Dan Brown | $27.95 |
| ... | ... | ... | ... |

**Type 1**

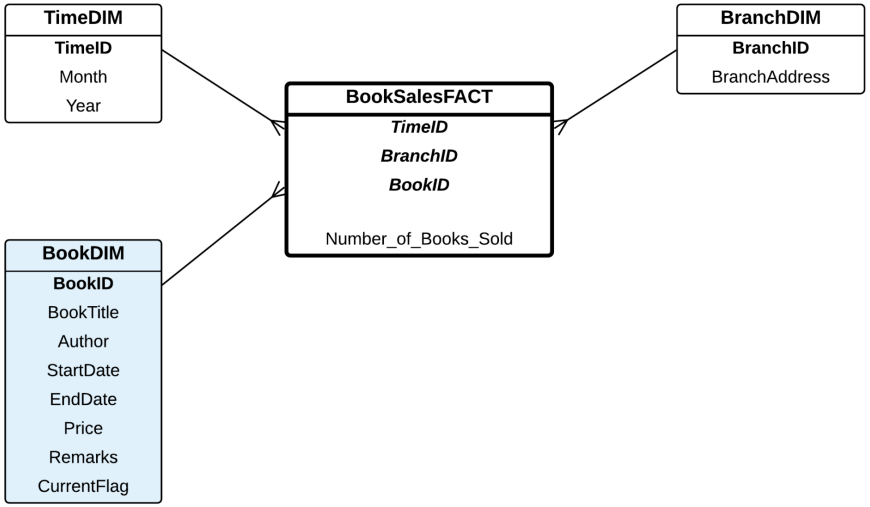
- Records the latest value of the records

| BookID | Book Title | Author | Price |
|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | $45.95 |
| H6 | Harry Potter 6 | Rowling | **$10.00** |
| DV | Da Vinci Code | Dan Brown | $27.95 |
| ... | ... | ... | ... |

**Similarity**: do not actually record the history of changes in the dimension

# 4.2. SCD Type 2

- Keeps track the history
- Not separating the history from the main dimension
- The new records keep added to the dimension



# 4.2. SCD Type 2

- Add sequence number to the original BookID to differentiate the same book in different time period

**Table 6.15** Book Dimension table (SCD Type 2)

| BookID | Book title | Author | Start Date | End Date | Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|
| **C1_1** | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Full Price | N |
| **C1_2** | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | 20% Discount | N |
| **C1_3** | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | Half Price | N |
| **C1_4** | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | Full Price | Y |
| **H6_1** | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Launching | N |
| **H6_2** | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | Full Price | N |
| **H6_3** | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | End of Product Sale | Y |
| **DV_1** | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Full Price | Y |
| ... | ... | ... | ... | ... | ... | ... | ... |

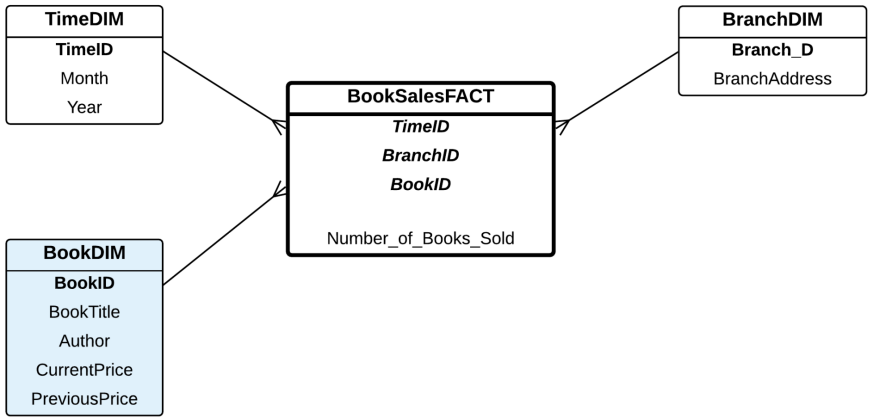
**Table 6.16** Report 3 (SCD Type 2)

| TimeID | BranchID | BookID | Book title | Author | Price | Number of books sold |
|---|---|---|---|---|---|---|
| Mar2008 | City | **C1_4** | CSIRO Diet | CSIRO Team | $45.95 | 5 |
| Mar2008 | City | **H6_3** | Harry Potter 6 | Rowling | $10.00 | 15 |
| Mar2008 | City | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 23 |
| Mar2008 | City | ... | ... | ... | ... | ... |
| Mar2008 | Chadstone | **C1_4** | CSIRO Diet | CSIRO Team | $45.95 | 15 |
| Mar2008 | Chadstone | **H6_3** | Harry Potter 6 | Rowling | $10.00 | 3 |
| Mar2008 | Chadstone | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Chadstone | ... | ... | ... | ... | ... |
| Mar2008 | Camberwell | **C1_4** | CSIRO Diet | CSIRO Team | $45.95 | 1 |
| Mar2008 | Camberwell | **H6_3** | Harry Potter 6 | Rowling | $10.00 | 1 |
| Mar2008 | Camberwell | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Mar2008 | Camberwell | ... | ... | ... | ... | ... |
| Mar2008 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |
| Dec2007 | City | **C1_3** | CSIRO Diet | CSIRO Team | $23.00 | 15 |
| Dec2007 | City | **H6_2** | Harry Potter 6 | Rowling | $30.95 | 6 |
| Dec2007 | City | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 6 |
| Dec2007 | City | .. | ... | ... | ... | ... |
| Dec2007 | Chadstone | **C1_3** | CSIRO Diet | CSIRO Team | $23.00 | 10 |
| Dec2007 | Chadstone | **H6_2** | Harry Potter 6 | Rowling | $30.95 | 8 |
| Dec2007 | Chadstone | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 1 |
| Dec2007 | Chadstone | .. | ... | ... | ... | ... |
| Dec2007 | Camberwell | **C1_3** | CSIRO Diet | CSIRO Team | $23.00 | 18 |
| Dec2007 | Camberwell | **H6_2** | Harry Potter 6 | Rowling | $30.95 | 3 |
| Dec2007 | Camberwell | **DV_1** | Da Vinci Code | Dan Brown | $27.95 | 2 |
| Dec2007 | Camberwell | .. | ... | ... | ... | ... |
| Dec2007 | ... | ... | ... | ... | ... | ... |
| ... | ... | ... | ... | ... | ... | ... |

# 4.3. SCD Type 3

- Simplification of Type 2
- Single value for each entry
- Assumed, complete history is not necessary
- Example: Records current and previous price

| BookID | Book Title | Author | Current Price | Previous Price |
|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | **$45.95** | **$23.00** |
| H6 | Harry Potter 6 | Rowling | **$10.00** | **$30.95** |
| DV | Da Vinci Code | Dan Brown | **$27.95** | **Null** |
| ... | ... | ... | ... | ... |



# 4.4. SCD Type 4

- Create a new dimension to maintain the history of attribute value change.
- Book Dimension table is kept without the price attribute.
- The price attribute (and Start Date and End Date) are separated into another table
- Do not need to have a different BookID for the same book

Book Dimension Table

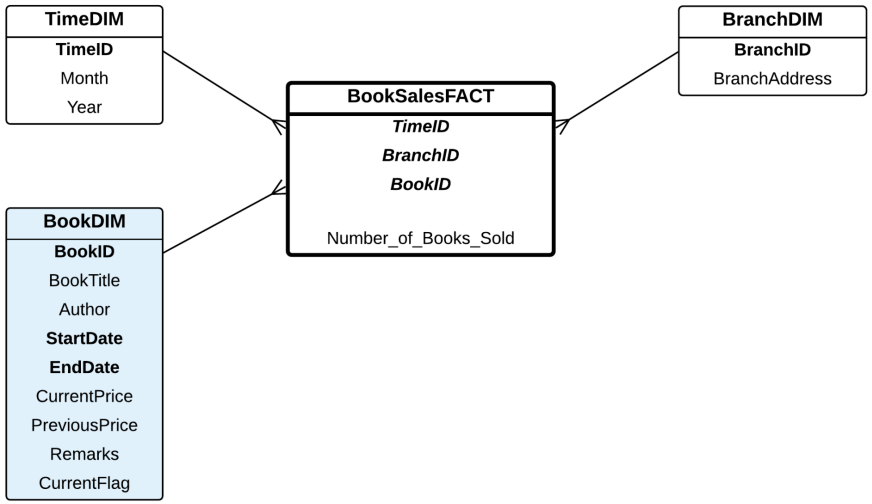
| BookID | Book Title | Author |
|---|---|---|
| C1 | CSIRO Diet | CSIRO Team |
| H6 | Harry Potter 6 | Rowling |
| DV | Da Vinci Code | Dan Brown |
| ... | ... | ... |

Book Price Dimension Table

| BookID | Start Date | End Date | Price | Remarks |
|---|---|---|---|---|
| C1 | Jan2007 | July2007 | $45.95 | Full Price |
| C1 | Aug2007 | Oct2007 | $36.75 | 20% Discount |
| C1 | Nov2007 | Jan2008 | $23.00 | Half Price |
| C1 | Feb2008 | Dec9999 | $45.95 | Full Price |
| H6 | Jan2007 | Mar2007 | $21.95 | Launching |
| H6 | Apr2007 | Jan2008 | $30.95 | Full Price |
| H6 | Feb2008 | Dec9999 | $10.00 | End of Product Sale |
| DV | Jan2007 | Dec9999 | $27.95 | Full Price |
| ... | ... | ... | ... | ... |

# 4.5. SCD Type 6

- Combination between Type 2 and Type 3
- A separate identifier for the same book is not needed, but the entire history is kept



# 4.5 SCD Type 6

**Table 6.15** Book Dimension table (SCD Type 2)

| BookID | Book title | Author | Start Date | End Date | Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|
| **C1_1** | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Full Price | N |
| **C1_2** | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | 20% Discount | N |
| **C1_3** | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | Half Price | N |
| **C1_4** | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | Full Price | Y |
| **H6_1** | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Launching | N |
| **H6_2** | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | Full Price | N |
| **H6_3** | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | End of Product Sale | Y |
| **DV_1** | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Full Price | Y |
| ... | ... | ... | ... | ... | ... | ... | ... |

Book Dimension Table (SCD Type 3)

| BookID | Book Title | Author | Current Price | Previous Price |
|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | **$45.95** | **$23.00** |
| H6 | Harry Potter 6 | Rowling | **$10.00** | **$30.95** |
| DV | Da Vinci Code | Dan Brown | **$27.95** | **Null** |
| ... | ... | ... | ... | ... |

**Table 6.20** Book Dimension (SCD Type 6)

| Book ID | Book Title | Author | Start Date | End Date | Current Price | Previous Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Null | Full Price | N |
| C1 | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | $45.95 | 20% Discount | N |
| C1 | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | $36.75 | Half Price | N |
| C1 | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | $23.00 | Full Price | Y |
| H6 | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Null | Launching | N |
| H6 | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | $21.95 | Full Price | N |
| H6 | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | $30.95 | End of Product | Y |
| DV | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Null | Full Price | Y |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

# 4.5. SCD Type 6

- The cardinality relationship between Book Dimension table and Fact table is no longer 1-*m*, but *m*-*m*
- Three options to solve the problem:
  1. Add new surrogate key to Book Dimension table
  2. Add Start Date and End Date to Fact table, in addition to the BookID
  3. Add associative table (or a bridge table) between Book Dimension and Fact

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

| BookID | Book Title | Author | Price |
|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | $45.95 |
| H6 | Harry Potter 6 | Rowling | $30.95 |
| DV | Da Vinci Code | Dan Brown | $27.95 |
| ... | ... | ... | ... |

## SCD Type 0

```
create table SCD0 as
select distinct
  B.BookID, B.BookTitle,
  B.Author, H.Price as OriginalPrice
from Book B, BookPriceHistory H
where B.BookID = H.BookID
and H.Remarks = 'Full Price';
```

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 1

| BookID | Book Title | Author | Price |
|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | $45.95 |
| H6 | Harry Potter 6 | Rowling | **$10.00** |
| DV | Da Vinci Code | Dan Brown | $27.95 |
| ... | ... | ... | ... |

```
create table SCD1 as
select
  T.BookID, T.BookTitle,
  T.Author, T.Price as CurrentPrice
from (
  select
    B.BookID, B.BookTitle, B.Author,
    to_date(H.StartDate, 'MonYYYY'), H.Price,
    rank() over( partition by B.BookID
       order by to_date(H.StartDate, 'MonYYYY') desc)
       as Rank
  from Book B, BookPriceHistory H
  where B.BookID = H.BookID) T
where T.Rank = 1;
```

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

**Table 6.15** Book Dimension table (SCD Type 2)

| BookID | Book title | Author | Start Date | End Date | Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|
| **C1_1** | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Full Price | N |
| **C1_2** | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | 20% Discount | N |
| **C1_3** | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | Half Price | N |
| **C1_4** | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | Full Price | Y |
| **H6_1** | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Launching | N |
| **H6_2** | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | Full Price | N |
| **H6_3** | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | End of Product Sale | Y |
| **DV_1** | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Full Price | Y |
| ... | ... | ... | ... | ... | ... | ... | ... |

## SCD Type 2

```
create table SCD2 as
select  B.BookID  || '_' ||
   rank() over(partition by B.BookID
     order by to_date(H.StartDate, 'MonYYYY') asc)
     as BookID,
  B.BookTitle, B.Author, H.StartDate,
  H.EndDate, H.Price, H.Remarks,
  case H.EndDate when 'Dec9999' then 'Y' else 'N'
  end as CurrentFlag
from Book B, BookPriceHistory H
where B.BookID = H.BookID;
```

# 4.6 Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 3

| BookID | Book Title | Author | Current Price | Previous Price |
|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | **$45.95** | **$23.00** |
| H6 | Harry Potter 6 | Rowling | **$10.00** | **$30.95** |
| DV | Da Vinci Code | Dan Brown | **$27.95** | **Null** |
| ... | ... | ... | ... | ... |

```
create table SCD3 as
select
  T1.BookID, T1.BookTitle, T1.Author,
  T1.CurrentPrice, T2.CurrentPrice as PreviousPrice
from (
  select
    T.BookID, T.BookTitle,
    T.Author, T.Price as CurrentPrice
  from (
     select
       B.BookID, B.BookTitle,
       B.Author, to_date(H.StartDate, 'MonYYYY'),
       H.Price,
       rank() over( partition by B.BookID
         order by to_date(H.StartDate, 'MonYYYY') desc)
         as Rank
     from Book B, BookPriceHistory H
     where B.BookID = H.BookID) T
  where T.Rank = 1) T1,
  (select
    T.BookID, T.BookTitle,
    T.Author, T.Price as CurrentPrice
  from (
    select
      B.BookID, B.BookTitle, B.Author,
      to_date(H.StartDate, 'MonYYYY'), H.Price,
      rank() over( partition by B.BookID
        order by to_date(H.StartDate, 'MonYYYY') desc)
        as Rank
    from Book B, BookPriceHistory H
    where B.BookID = H.BookID) T
  where T.Rank = 2) T2
where T1.BookID = T2.BookID(+);
```

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 4

```
create table SCD4 as
select * from BookPriceHistory;
```

Book Dimension Table

| BookID | Book Title | Author |
|---|---|---|
| C1 | CSIRO Diet | CSIRO Team |
| H6 | Harry Potter 6 | Rowling |
| DV | Da Vinci Code | Dan Brown |
| ... | ... | ... |

Book Price Dimension Table

| BookID | Start Date | End Date | Price | Remarks |
|---|---|---|---|---|
| C1 | Jan2007 | July2007 | $45.95 | Full Price |
| C1 | Aug2007 | Oct2007 | $36.75 | 20% Discount |
| C1 | Nov2007 | Jan2008 | $23.00 | Half Price |
| C1 | Feb2008 | Dec9999 | $45.95 | Full Price |
| H6 | Jan2007 | Mar2007 | $21.95 | Launching |
| H6 | Apr2007 | Jan2008 | $30.95 | Full Price |
| H6 | Feb2008 | Dec9999 | $10.00 | End of Product Sale |
| DV | Jan2007 | Dec9999 | $27.95 | Full Price |
| ... | ... | ... | ... | ... |

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 6

Step 1: Join between SCD2 and SCD3

**Table 6.21** Join between SCD Type 2 and SCD Type 3

| Book ID | Book Title | Author | Start Date | End Date | Price | Remarks | Current Flag | Order Number |
|---|---|---|---|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Full Price | N | **1** |
| C1 | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | 20% Discount | N | **2** |
| C1 | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | Half Price | N | **3** |
| C1 | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | Full Price | Y | **4** |
| DV | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Full Price | Y | **1** |
| H6 | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Launching | N | **1** |
| H6 | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | Full Price | N | **2** |
| H6 | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | End of Product | Y | **3** |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

```
select
  SCD3.BookID,
  SCD2.BookTitle, SCD2.Author,
  SCD2.StartDate, SCD2.EndDate,
  SCD2.Price, SCD2.Remarks, SCD2.CurrentFlag,
  row_number() over
    (partition by SCD3.BookID
     order by SCD3.BookID, SCD2.StartDate) as
     OrderNumber
  from SCD2, SCD3
where SCD2.BookID like SCD3.BookID||'_%'
order by SCD3.BookID, SCD2.StartDate;
```

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 6

Step 2: Self-Join (incorrect)

**Table 6.22** Self-join results

| Book ID | Book Title | Author | Start Date | End Date | Current Price | Previous Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | $45.95 | 20% Discount | N |
| C1 | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | $36.75 | Half Price | N |
| C1 | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | $23.00 | Full Price | Y |
| H6 | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | $21.95 | Full Price | N |
| H6 | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | $30.95 | End of Product | Y |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

```
select
  T1.BookID, T1.BookTitle, T1.Author,
  T1.StartDate, T1.EndDate,
  T1.Price as CurrentPrice,
  T2.Price as PreviousPrice,
  T1.Remarks, T1.CurrentFlag
from (
  select SCD3.BookID,
    SCD2.BookTitle, SCD2.Author, SCD2.StartDate,
    SCD2.EndDate, SCD2.Price, SCD2.Remarks,
    SCD2.CurrentFlag,
    row_number() over
      (partition by SCD3.BookID
       order by SCD3.BookID, SCD2.StartDate) as
       OrderNumber
    from SCD2, SCD3
  where SCD2.BookID like SCD3.BookID||'_%'
  order by SCD3.BookID, SCD2.StartDate) T1,
  (
  select SCD3.BookID,
    SCD2.BookTitle, SCD2.Author, SCD2.StartDate,
    SCD2.EndDate, SCD2.Price, SCD2.Remarks,
    SCD2.CurrentFlag,
    row_number() over
      (partition by SCD3.BookID
       order by SCD3.BookID, SCD2.StartDate) + 1 as
       OrderNumber
    from SCD2, SCD3
  where SCD2.BookID like SCD3.BookID||'_%'
  order by SCD3.BookID, SCD2.StartDate) T2
where T1.BookID = T2.BookID
and T1.OrderNumber = T2.OrderNumber
order by T1.BookID, T1.StartDate;
```

# 4.6. Implementation of SCD in SQL

- **Book** (BookID, BookTitle, Author)
- **BookPriceHistory** (BookID, StartDate, EndDate, Price, Remarks)

## SCD Type 6

Step 2: Self-Join (CORRECT)

**Table 6.23** The correct self-join results (SCD Type 6)

| Book ID | Book Title | Author | Start Date | End Date | Current Price | Previous Price | Remarks | Current Flag |
|---|---|---|---|---|---|---|---|---|
| C1 | CSIRO Diet | CSIRO Team | Jan2007 | Jul2007 | $45.95 | Null | Full Price | N |
| C1 | CSIRO Diet | CSIRO Team | Aug2007 | Oct2007 | $36.75 | $45.95 | 20% Discount | N |
| C1 | CSIRO Diet | CSIRO Team | Nov2007 | Jan2008 | $23.00 | $36.75 | Half Price | N |
| C1 | CSIRO Diet | CSIRO Team | Feb2008 | Dec9999 | $45.95 | $23.00 | Full Price | Y |
| DV | Da Vinci Code | Dan Brown | Jan2007 | Dec9999 | $27.95 | Null | Full Price | Y |
| H6 | Harry Potter 6 | Rowling | Jan2007 | Mar2007 | $21.95 | Null | Launching | N |
| H6 | Harry Potter 6 | Rowling | Apr2007 | Jan2008 | $30.95 | $21.95 | Full Price | N |
| H6 | Harry Potter 6 | Rowling | Feb2008 | Dec9999 | $10.00 | $30.95 | End of Product | Y |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |

```
where T1.BookID = T2.BookID (+)
and T1.OrderNumber = T2.OrderNumber (+)
```

# 4.7. Creating the Fact Tables

- SCD Types 0,1,3,4:
  - The Book ID attributes are exactly the same as the Book ID in the "non-temporal" version
  - Fact table will not be affected
  - The number of records in dimension is the same
- SCD Type 4 is used
  - Maintain the complete history of Book Price
  - Produce correct reports when joining with the Fact Table

# 4.7. Creating the Fact Tables

- SCD Types 2:
  - The number of records is not the same as the original Book Dimension table
  - The contents of the Fact Table must contain the correct Book ID
- Notes
  - It joins with the Book Dimension SCD Type 2
  - The join condition uses a LIKE
  - the join condition must include checking the dates

```
create table BookSalesFactWithSCD2 as
select
  to_char(T.TransactionDate, 'MonYYYY') as TimeID,
  BK.BookID,
  BR.BranchID,
  sum(T.Quantity) as Number_of_Books_Sold
from BookTransaction T, SCD2 BK, Branch BR
where T.BranchID = BR.BranchID
and BK.BookID like T.BookID||'_%'
and to_date(BK.StartDate, 'MonYYYY') <= T.TransactionDate
and T.TransactionDate <= to_date(BK.EndDate, 'MonYYYY')
group by
  to_char(T.TransactionDate, 'MonYYYY'),
  BK.BookID,
  BR.BranchID;
```

| TimeID | BranchID | BookID | Number of books sold |
|---|---|---|---|
| Mar2008 | City | **C1_4** | 5 |
| Mar2008 | City | **H6_3** | 15 |
| Mar2008 | City | **DV_1** | 23 |
| Mar2008 | City | ... | ... |
| Mar2008 | Chadstone | **C1_4** | 15 |
| Mar2008 | Chadstone | **H6_3** | 3 |
| Mar2008 | Chadstone | **DV_1** | 2 |
| Mar2008 | Chadstone | ... | ... |
| Mar2008 | Camberwell | **C1_4** | 1 |
| Mar2008 | Camberwell | **H6_3** | 1 |
| Mar2008 | Camberwell | **DV_1** | 2 |
| Mar2008 | Camberwell | ... | ... |
| Mar2008 | ... | ... | ... |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Dec2007 | City | **C1_3** | 15 |
| Dec2007 | City | **H6_2** | 6 |
| Dec2007 | City | **DV_1** | 6 |
| Dec2007 | City | .. | ... |
| Dec2007 | Chadstone | **C1_3** | 10 |
| Dec2007 | Chadstone | **H6_2** | 8 |
| Dec2007 | Chadstone | **DV_1** | 1 |
| Dec2007 | Chadstone | .. | ... |
| Dec2007 | Camberwell | **C1_3** | 18 |
| Dec2007 | Camberwell | **H6_2** | 3 |
| Dec2007 | Camberwell | **DV_1** | 2 |
| Dec2007 | Camberwell | .. | ... |
| Dec2007 | ... | ... | ... |
| ... | ... | ... | ... |

# 4.7. Creating the Fact Tables

- SCD Type 6
  - Book ID does not change
  - In the join condition, it simply compares the Book ID from SCD Type 6 and the Book Transaction table

```
create table BookSalesFactWithSCD6 as
select
  to_char(T.TransactionDate, 'MonYYYY') as TimeID,
  BK.BookID,
  BR.BranchID,
  sum(T.Quantity) as Number_of_Books_Sold
from BookTransaction T, SCD6 BK, Branch BR
where T.BranchID = BR.BranchID
and BK.BookID = T.BookID
and to_date(BK.StartDate, 'MonYYYY') <= T.TransactionDate
and T.TransactionDate <= to_date(BK.EndDate, 'MonYYYY')
group by
  to_char(T.TransactionDate, 'MonYYYY'),
  BK.BookID,
  BR.BranchID;
```

| TimeID | BranchID | BookID | Number of books sold |
|---|---|---|---|
| Mar2008 | City | **C1** | 5 |
| Mar2008 | City | **H6** | 15 |
| Mar2008 | City | **DV** | 23 |
| Mar2008 | City | ... | ... |
| Mar2008 | Chadstone | **C1** | 15 |
| Mar2008 | Chadstone | **H6** | 3 |
| Mar2008 | Chadstone | **DV** | 2 |
| Mar2008 | Chadstone | ... | ... |
| Mar2008 | Camberwell | **C1** | 1 |
| Mar2008 | Camberwell | **H6** | 1 |
| Mar2008 | Camberwell | **DV** | 2 |
| Mar2008 | Camberwell | ... | ... |
| Mar2008 | ... | ... | ... |
| ... | ... | ... | ... |
| ... | ... | ... | ... |
| Dec2007 | City | **C1** | 15 |
| Dec2007 | City | **H6** | 6 |
| Dec2007 | City | **DV** | 6 |
| Dec2007 | City | .. | ... |
| Dec2007 | Chadstone | **C1** | 10 |
| Dec2007 | Chadstone | **H6** | 8 |
| Dec2007 | Chadstone | **DV** | 1 |
| Dec2007 | Chadstone | .. | ... |
| Dec2007 | Camberwell | **C1** | 18 |
| Dec2007 | Camberwell | **H6** | 3 |
| Dec2007 | Camberwell | **DV** | 2 |
| Dec2007 | Camberwell | .. | ... |
| Dec2007 | ... | ... | ... |
| ... | ... | ... | ... |

# Summary

- A temporal data warehousing uses the concept of the Bridge Table (or a Weak Entity)
- The history is maintained in a bridge table
- Maintaining the history of certain attributes is important when analysing the reports produced by the fact and dimensions
- Temporal data warehousing is known as *Slowly Changing Dimensions* (*SCD*)
- Several SCD types are discussed