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Advanced Time Intelligence in DAX

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- Founder of www.sqlbi.com
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  - Complex Project Assistance
  - Data Warehouse Assessments and Development
  - Courses, Trainings and Workshops
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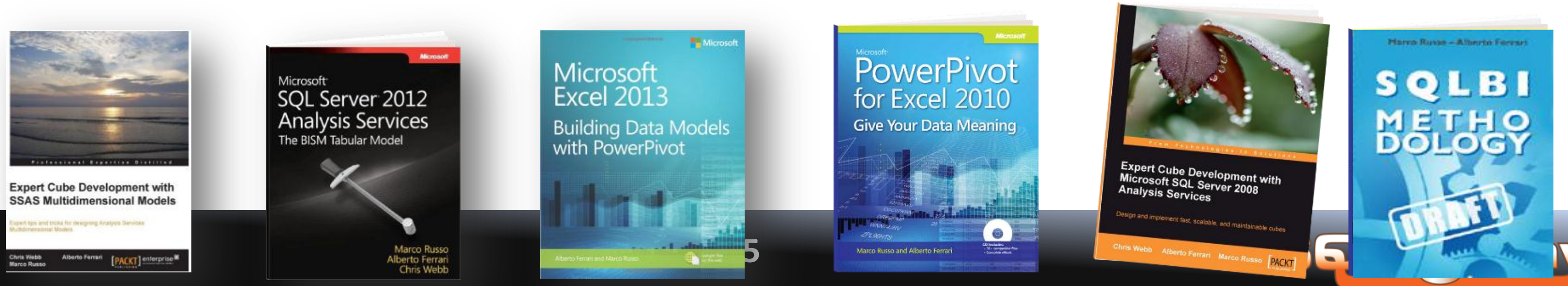
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What is Time Intelligence?

- Many different topics in one name
  - Year To Date
  - Quarter To Date
  - Running Total
  - Same period previous year
  - Working days computation
  - Fiscal Year
- In short: anything related with time
  - Handled in an intelligent way

Date Table

- Time intelligence needs a date table
  - Built in DAX
  - Or in a SQL Table
- Date table properties
  - All dates should be present
  - From 1° of January, to 31° of December
  - No holes
  - Otherwise time intelligence will not work

Create a Date Table

- Stored in a SQL table inside the DWH
- Optional
  - Create a holidays table
  - Useful for working days calculations
- Set all the necessary attributes
  - Do not create them in DAX
  - SQL is the best place for all attributes
- Building a view is always the best option

CALENDAR

2015

Returns a table with a single column named “Date” containing a contiguous set of dates in the given range, inclusive.

```
CALENDAR (
      DATE ( 2005,  1,  1 ),
      DATE ( 2015, 12, 31 )
)


CALENDAR (
    MIN ( Sales[OrderDate] ),
    MAX ( Sales[OrderDate] )
)
```

CALENDAR

If you have multiple fact tables, you need to compute the correct values

```
=CALENDAR (
       MIN (
              MIN ( Sales[OrderDate] ),
              MIN ( Purchases[PurchaseDate] )
       ),
       MAX (
              MAX ( Sales[OrderDate] ),
              MAX ( Purchases[PurchaseDate] )
       )
)
```

CALENDARAUTO

2015

Automatically creates a calendar table, including the dates including the fiscal years (both start and end)

```
--
--     The parameter is the starting month
--     of the fiscal year
--
= CALENDARAUTO (
    6
)
```

Beware: CALENDARAUTO uses all the dates in your model, excluding only calculated columns and tables

Mark as Date Table

- Need to mark the calendar as date table
- Set the column containing the date
- Needed to make time intelligence works
- Used by client tools as metadata information
  - Power View
  - Q&A
  - Excel
- Multiple tables can be marked as date table

Set Sorting Options

- Month names do not sort alphabetically
  - April is not the first month of the year
- Use Sort By Column
- Set all sorting options in the proper way
- Beware of sorting granularity
  - 1:1 between names and sort keys

Handling DateTime

- If time is a useful information
- Separate Date from Time
  - Date part → Calendar Table
  - Time part → Time Table
- Reduces distinct values
- Makes analysis much easier
- Time can often be normalized in time ranges of 5, 10 or 30 minutes

Multiple Dates

- Date is often a role dimension
  - Many roles for a date
  - Many date tables
- How many date tables?
  - Try to use only one table
  - Use many, only if needed by the model
  - Many date tables lead to confusion
    - And issues when slicing
- Use proper naming convention

Counting Working Days

- How many working days in a date range?
  - Easily solved with Calendar table
  - Define a new column «WorkingDays»
  - Aggregate with SUM
- Handles any date range
- Works on periods with «holes»
- No separation between fact tables and dimensions in Tabular

Aggregations Over Time

- Many useful aggregations
  - YTD: Year To Date
  - QTD: Quarter To Date
  - MTD: Month To Date
- They all need a Calendar Table
- And some understanding of CALCULATE

Year To Date: the easy way

TOTALYTD: the “DAX for dummies” version

```
SalesAmountYTD :=

TOTALYTD (
    SUM ( Sales[SalesAmount] ),
    'Date'[Date]
)
```

Handling Fiscal Year

The last, optional, parameter is the end of the fiscal year
Default: 12-31 (or 31/12 - locale dependent)

```
SalesAmountYTD :=

TOTALYTD (
    SUM ( Sales[SalesAmount] ),
    'Date'[Date],
    "06-30"
)
```

Year To Date: the DAX way

- DATESYTD: Returns a set of dates, from the start of the year up to the parameter date

- CALCULATE: Creates a filter context and performs the SUM operation

```
SalesAmountYTD :=

CALCULATE (
    SUM ( Sales[SalesAmount] ),
    DATESYTD ( 'Date'[Date] )
)
```

Same Period Last Year

Same period in previous year. CALCULATE is needed

Specialized version of DATEADD

```
Sales_SPLY :=

CALCULATE (
    SUM ( Sales[SalesAmount] ),
    SAMEPERIODLASTYEAR ( 'Date'[Date] )
)
```

Mixing Time Intelligence Functions

YTD on the previous year. In DAX, it is very simple, just mix the functions to obtain the result

```
Sales_YTDLY :=

CALCULATE (
    SUM ( Sales[SalesAmount] ),
    DATESYTD (
        SAMEPERIODLASTYEAR ( 'Date'[Date] )
    )
)
```

DATEADD

Similar as SAMEPERIODLASTYEAR, used to calculate different periods: YEAR, MONTH, DAY …

Does not sum dates, it shifts periods over time

```
Sales_SPLY :=

CALCULATE (
    SUM( Sales[SalesAmount] ),
    DATEADD ( 'Date'[Date] , -1, YEAR )
)
```

PARALLELPERIOD

Returns a set of dates (a table) shifted in time

The whole period is returned, regardless dates in the first parameter

```
Sales_PPLY :=

CALCULATE (
    SUM ( Sales[SalesAmount] ),
    PARALLELPERIOD ( 'Date'[Date] , -1, YEAR )
)
```

Running Total

Running total, as most of the more complex time intelligence aggregations, needs the CALCULATE version, because there is no syntax sugar here

```
SalesAmountRT :=

CALCULATE (
    SUM ( Sales[SalesAmount] ),
    FILTER (
        ALL ( 'Date' ),
       'Date'[Date] <= MAX ( 'Date'[Date] )
    )
)
```

Moving Annual Total

Moving window from the current date back one year

```
CALCULATE (
    SUM ( Sales[SalesAmount] ),
    DATESBETWEEN (
        'Date'[Date],
        NEXTDAY (
            SAMEPERIODLASTYEAR (
                LASTDATE ( 'Date'[Date] )
            )
        ),
        LASTDATE ( 'Date'[Date] )
    )
)
```

There are many week scenarios, depending on what you mean by «week»… CALCULATE is your best friend here

CALCULATIONS OVER WEEKS

Custom Calendars

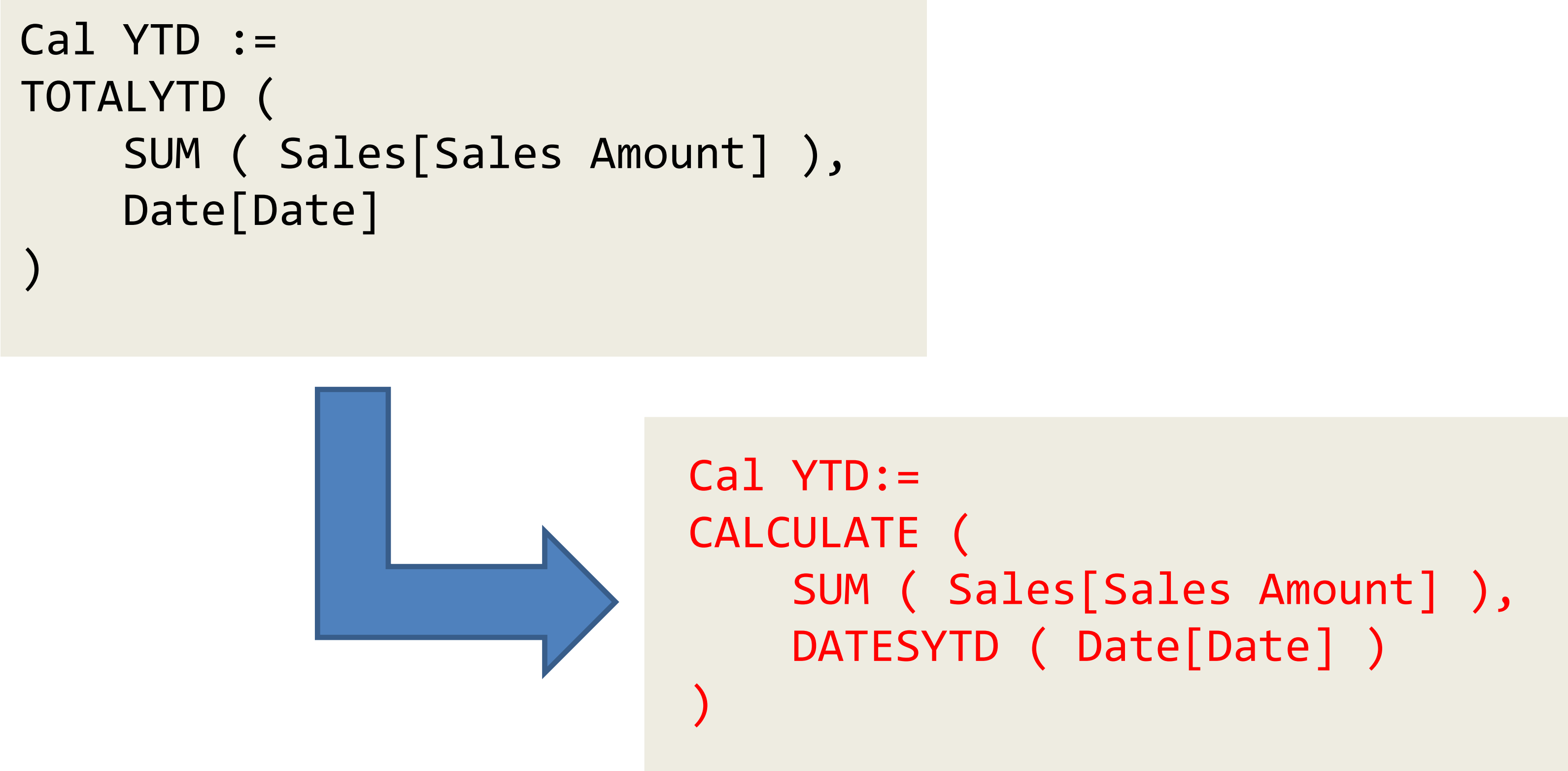
- Time Intelligence functions
  - One day belong to the same quarter every day
  - Not true if you use week calculations
- 4-4-5, 4-5-4, 5-4-4 ?????
  - One quarter is made of three months
  - Two of 4 weeks
  - One of 5 weeks
  - Difference only in position of the 5 weeks month
- No support in DAX for these calendars

Create Week Numbers

- Usually stored in the database
- If not, use Excel to compute them
- Or, as a better solution, use Power Query
  - M code is included in the attendee's pack!
  - Just copy and paste in Power Query

Time intelligence under the Hood

TOTALYTD is internally transformed into a CALCULATE statement



```
Cal YTD :=
TOTALYTD (
    SUM ( Sales[Sales Amount] ),
    Date[Date]
)
```

```
Cal YTD:=
CALCULATE (
    SUM ( Sales[Sales Amount] ),
    DATESYTD ( Date[Date] )
)
```

YTD without DATESYTD

You can compute YTD even if DATESYTD was not available, it is harder but it works the very same way

```
Cal YTD: :=
IF (
    HASONEVALUE ( Date[Year] ),
    CALCULATE (
        SUM ( Sales[Sales Amount] ),
        FILTER (
            ALL ( Date ),
            Date[Date] <= MAX ( Date[Date] )
        ),
        VALUES ( Date[Year] )
    )
)
```

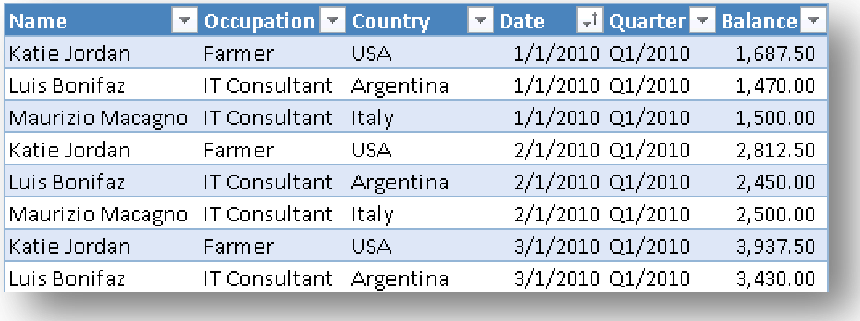
Week Calculations

- Fine, so how to work with weeks?
- Easier to look at a demo ☺

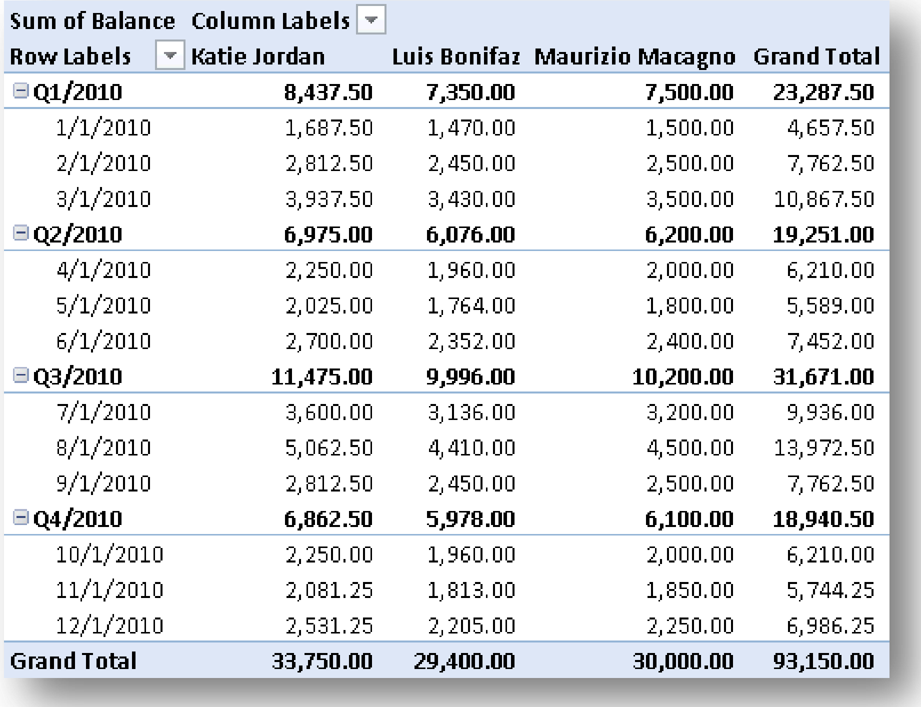
Semi Additive Measures

- Additive Measure
  - SUM over all dimensions
- Semi Additive Measure
  - SUM over some dimensions
  - Different function over other dimensions
  - Time is the standard exception for aggregations
  - Examples
    - Warehouse stocking
    - Current account balance

Current Account Balance



Name ▾	Occupation ▾	Country ▾	Date ▾	Quarter ▾	Balance ▾
Katie Jordan	Farmer	USA	1/1/2010	Q1/2010	1,687.50
Luis Bonifaz	IT Consultant	Argentina	1/1/2010	Q1/2010	1,470.00
Maurizio Macagno	IT Consultant	Italy	1/1/2010	Q1/2010	1,500.00
Katie Jordan	Farmer	USA	2/1/2010	Q1/2010	2,812.50
Luis Bonifaz	IT Consultant	Argentina	2/1/2010	Q1/2010	2,450.00
Maurizio Macagno	IT Consultant	Italy	2/1/2010	Q1/2010	2,500.00
Katie Jordan	Farmer	USA	3/1/2010	Q1/2010	3,937.50
Luis Bonifaz	IT Consultant	Argentina	3/1/2010	Q1/2010	3,430.00

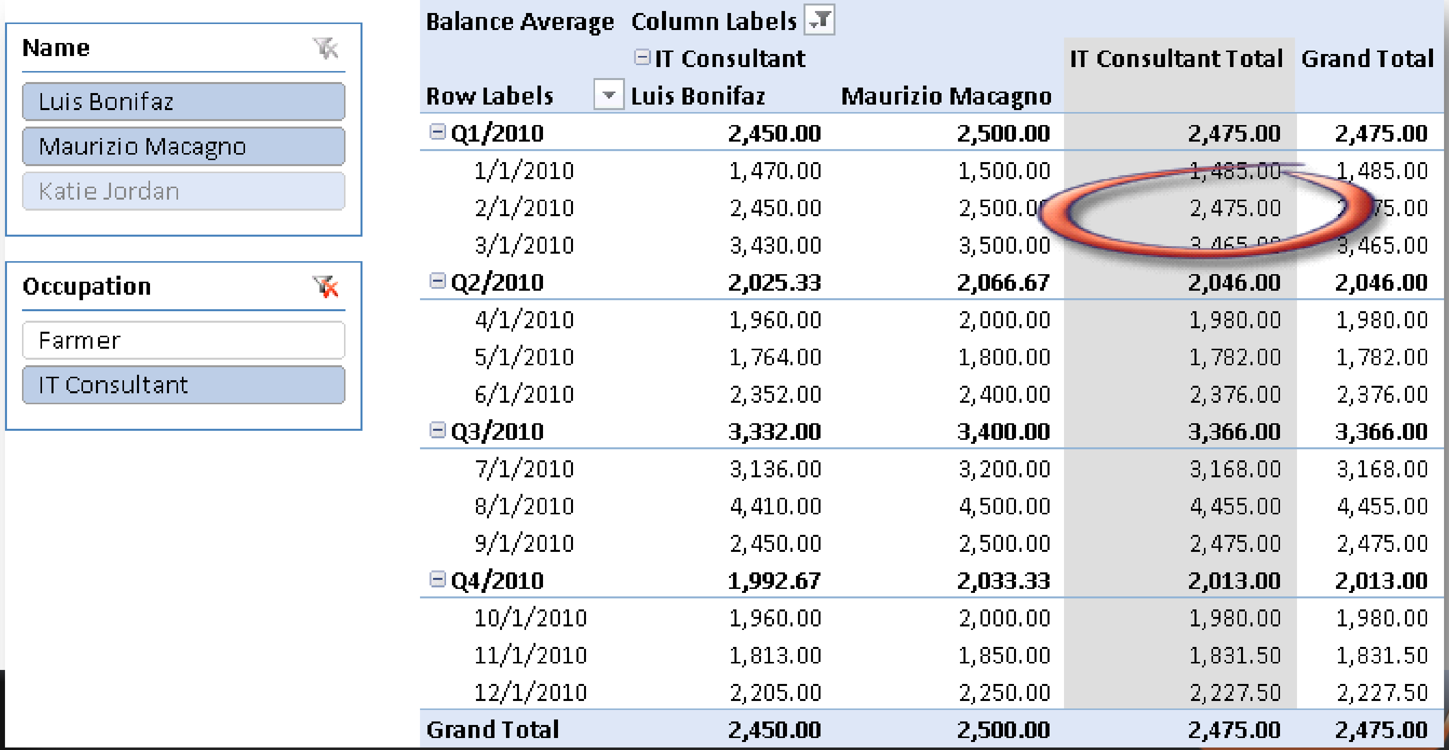


Sum of Balance	Column Labels ▾			
Row Labels ▾	Katie Jordan	Luis Bonifaz	Maurizio Macagno	Grand Total
⊟Q1/2010	**8,437.50**	**7,350.00**	**7,500.00**	**23,287.50**
1/1/2010	1,687.50	1,470.00	1,500.00	4,657.50
2/1/2010	2,812.50	2,450.00	2,500.00	7,762.50
3/1/2010	3,937.50	3,430.00	3,500.00	10,867.50
⊟Q2/2010	**6,975.00**	**6,076.00**	**6,200.00**	**19,251.00**
4/1/2010	2,250.00	1,960.00	2,000.00	6,210.00
5/1/2010	2,025.00	1,764.00	1,800.00	5,589.00
6/1/2010	2,700.00	2,352.00	2,400.00	7,452.00
⊟Q3/2010	**11,475.00**	**9,996.00**	**10,200.00**	**31,671.00**
7/1/2010	3,600.00	3,136.00	3,200.00	9,936.00
8/1/2010	5,062.50	4,410.00	4,500.00	13,972.50
9/1/2010	2,812.50	2,450.00	2,500.00	7,762.50
⊟Q4/2010	**6,862.50**	**5,978.00**	**6,100.00**	**18,940.50**
10/1/2010	2,250.00	1,960.00	2,000.00	6,210.00
11/1/2010	2,081.25	1,813.00	1,850.00	5,744.25
12/1/2010	2,531.25	2,205.00	2,250.00	6,986.25
Grand Total	**33,750.00**	**29,400.00**	**30,000.00**	**93,150.00**

- Month level correct
- Quarter level wrong
- Year level wrong

Semi additive measures

- Aggregation depends on the filter
  - LastChild over time
  - SUM for the other dimensions



Name

- Luis Bonifaz
- Maurizio Macagno
- Katie Jordan

Occupation

- Farmer
- IT Consultant

Balance Average	Column Labels			
	IT Consultant		IT Consultant Total	Grand Total
Row Labels	Luis Bonifaz	Maurizio Macagno		
Q1/2010	**2,450.00**	**2,500.00**	**2,475.00**	**2,475.00**
1/1/2010	1,470.00	1,500.00	1,485.00	1,485.00
2/1/2010	2,450.00	2,500.00	2,475.00	2,475.00
3/1/2010	3,430.00	3,500.00	3,465.00	3,465.00
Q2/2010	**2,025.33**	**2,066.67**	**2,046.00**	**2,046.00**
4/1/2010	1,960.00	2,000.00	1,980.00	1,980.00
5/1/2010	1,764.00	1,800.00	1,782.00	1,782.00
6/1/2010	2,352.00	2,400.00	2,376.00	2,376.00
Q3/2010	**3,332.00**	**3,400.00**	**3,366.00**	**3,366.00**
7/1/2010	3,136.00	3,200.00	3,168.00	3,168.00
8/1/2010	4,410.00	4,500.00	4,455.00	4,455.00
9/1/2010	2,450.00	2,500.00	2,475.00	2,475.00
Q4/2010	**1,992.67**	**2,033.33**	**2,013.00**	**2,013.00**
10/1/2010	1,960.00	2,000.00	1,980.00	1,980.00
11/1/2010	1,813.00	1,850.00	1,831.50	1,831.50
12/1/2010	2,205.00	2,250.00	2,227.50	2,227.50
Grand Total	**2,450.00**	**2,500.00**	**2,475.00**	**2,475.00**

SemiAdditive Measures

CALCULATE: to set the filter
LASTDATE: to find the last child

```
LastBalance :=

CALCULATE (
    SUM ( Balances[Balance] ),
    LASTDATE ( Date[Date] )
)
```

Last Non Blank

Searches in the fact table for the last non empty date.
Remember: LASTNONBLANK is an iterator

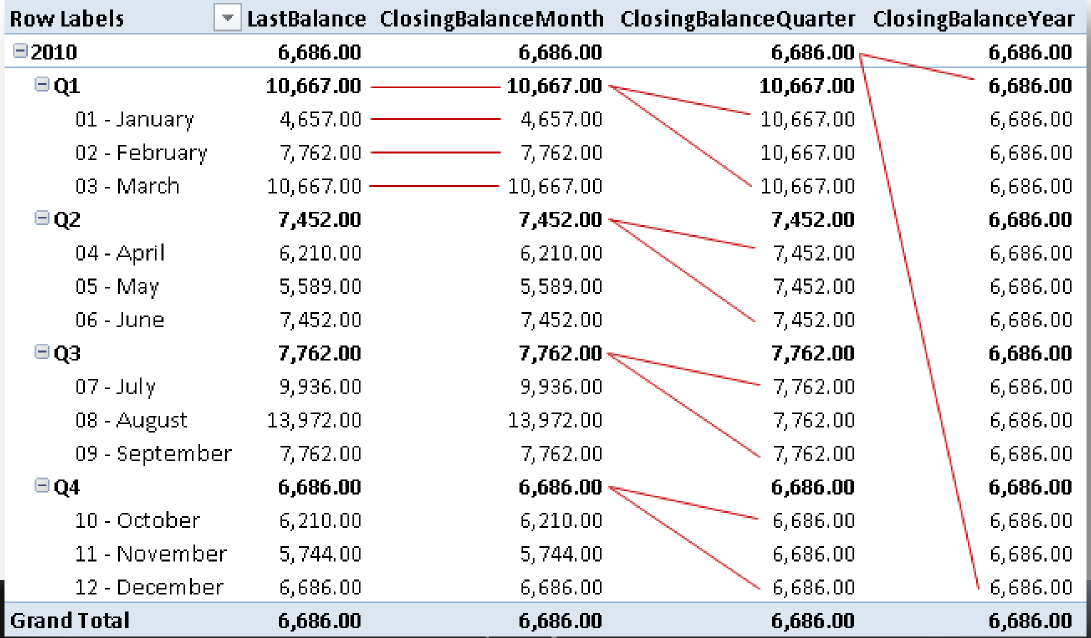
```
LastBalanceNonBlank :=

CALCULATE (
    SUM ( Balances[Balance] ),
    LASTNONBLANK (
        BalanceDate[Date],
        CALCULATE ( COUNTROWS ( Balances ) )
    )
)
```

Opening and Closing Balance

ClosingBalanceMonth =
CLOSINGBALANCEMONTH (SUM (Balances[Balance]), BalanceDate[Date])

ClosingBalanceQuarter =
CLOSINGBALANCEQUARTER (SUM (Balances[Balance]), BalanceDate[Date])

ClosingBalanceYear =
CLOSINGBALANCEYEAR (SUM (Balances[Balance]), BalanceDate[Date])



Row Labels	LastBalance	ClosingBalanceMonth	ClosingBalanceQuarter	ClosingBalanceYear
⊟2010	**6,686.00**	**6,686.00**	**6,686.00**	**6,686.00**
⊟Q1	**10,667.00**	**10,667.00**	**10,667.00**	**6,686.00**
01 - January	4,657.00	4,657.00	10,667.00	6,686.00
02 - February	7,762.00	7,762.00	10,667.00	6,686.00
03 - March	10,667.00	10,667.00	10,667.00	6,686.00
⊟Q2	**7,452.00**	**7,452.00**	**7,452.00**	**6,686.00**
04 - April	6,210.00	6,210.00	7,452.00	6,686.00
05 - May	5,589.00	5,589.00	7,452.00	6,686.00
06 - June	7,452.00	7,452.00	7,452.00	6,686.00
⊟Q3	**7,762.00**	**7,762.00**	**7,762.00**	**6,686.00**
07 - July	9,936.00	9,936.00	7,762.00	6,686.00
08 - August	13,972.00	13,972.00	7,762.00	6,686.00
09 - September	7,762.00	7,762.00	7,762.00	6,686.00
⊟Q4	**6,686.00**	**6,686.00**	**6,686.00**	**6,686.00**
10 - October	6,210.00	6,210.00	6,686.00	6,686.00
11 - November	5,744.00	5,744.00	6,686.00	6,686.00
12 - December	6,686.00	6,686.00	6,686.00	6,686.00
Grand Total	**6,686.00**	**6,686.00**	**6,686.00**	**6,686.00**

Opening and Closing Balance

DAX Function	Equivalent date filter in CALCULATE
OPENINGBALANCEMONTH	STARTOFMONTH
OPENINGBALANCEQUARTER	STARTOFQUARTER
OPENINGBALANCEYEAR	STARTOFYEAR
CLOSINGBALANCEMONTH	ENDOFMONTH
CLOSINGBALANCEQUARTER	ENDOFQUARTER
CLOSINGBALANCEYEAR	ENDOFYEAR

Time Intelligence: Conclusions

- Based on evaluation contexts
  - Replace filter on date
  - Many predefined functions
  - You can author your own functions
- Basic Time Itelligence
- Creating more complex aggregations
- Working with ISO weeks

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