Window functions

INTERMEDIATE SQL SERVER

SQL

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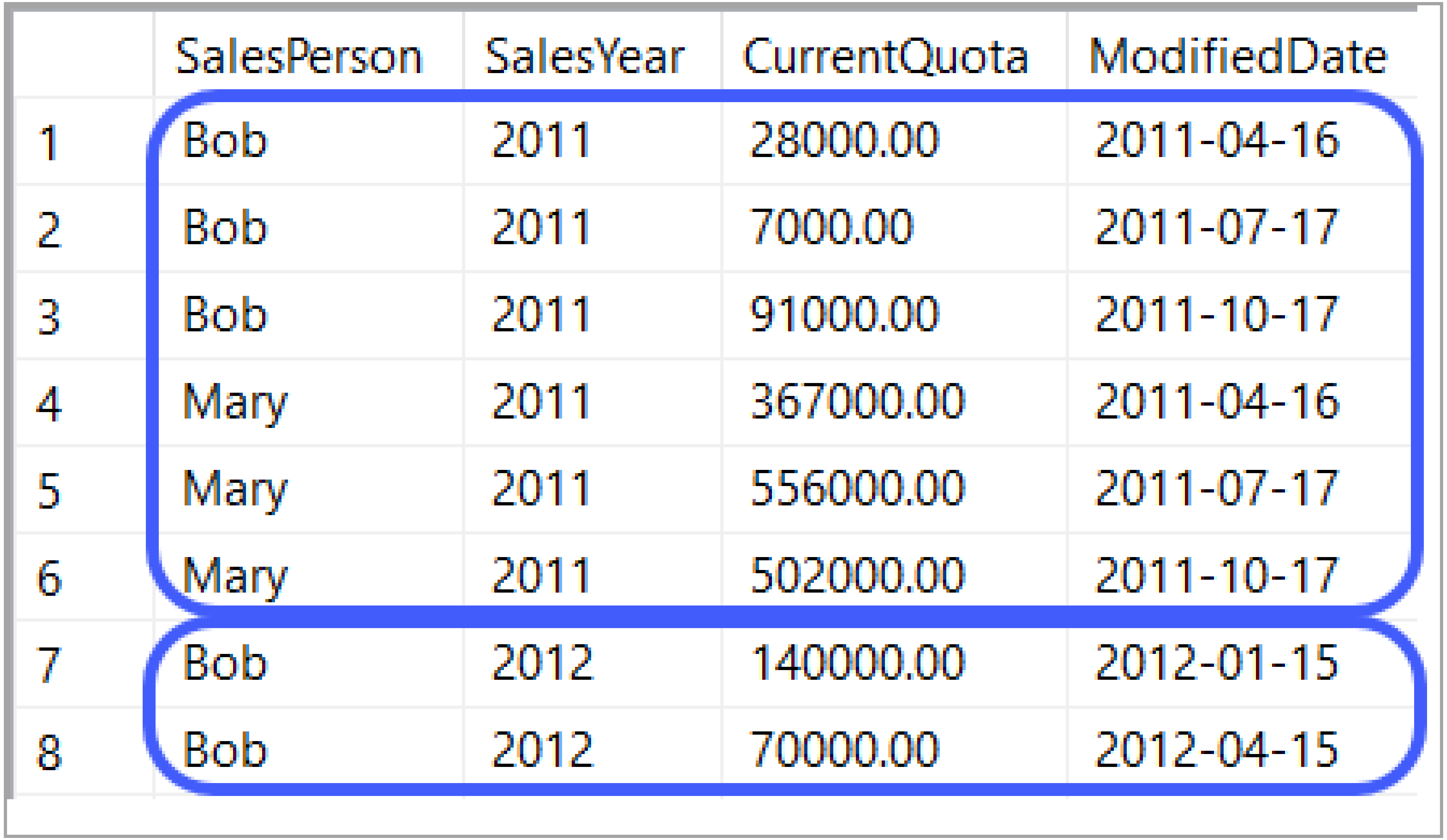

	SalesPerson	SalesYear	CurrentQuota	ModifiedDate
1	Bob	2011	28000.00	2011-04-16
2	Bob	2011	7000.00	2011-07-17
3	Bob	2011	91000.00	2011-10-17
4	Mary	2011	367000.00	2011-04-16
5	Mary	2011	556000.00	2011-07-17
6	Mary	2011	502000.00	2011-10-17
7	Bob	2012	140000.00	2012-01-15
8	Bob	2012	70000.00	2012-04-15

Grouping data in T-SQL

```
SELECT SalesPerson, SalesYear,
       CurrentQuota, ModifiedDate
FROM SaleGoal
WHERE SalesYear = 2011
```

```
+------------+----------+---------------+----------------+
|SalesPerson |SalesYear | CurrentQuota  | ModifiedDate   |
+------------+----------+---------------+----------------+
| Bob        | 2011     | 28000.00      | 2011-04-16     |
| Bob        | 2011     |  7000.00      | 2011-07-16     |
| Bob        | 2011     | 91000.00      | 2011-10-16     |
| Mary       | 2011     |367000.00      | 2011-04-16     |
| Mary       | 2011     |556000.00      | 2011-07-16     |
| Mary       | 2011     |502000.00      | 2011-10-16     |
+------------+----------+---------------+----------------+
```

Window syntax in T-SQL

- Create the window with `OVER` clause
- `PARTITION BY` creates the frame
- If you do not include `PARTITION BY` the frame is the entire table
- To arrange the results, use `ORDER BY`
- Allows aggregations to be created at the same time as the window

```
. . .
-- Create a Window data grouping
OVER (PARTITION BY SalesYear ORDER BY SalesYear)
```

Window functions (SUM)

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       SUM(CurrentQuota)
       OVER (PARTITION BY SalesYear) AS YearlyTotal,
       ModifiedDate AS ModDate
FROM SaleGoal
```

```
+------------+----------+-------------+-----------+----------+
|SalesPerson |SalesYear |CurrentQuota |YearlyTotal | ModDate  |
+------------+----------+-------------+-----------+----------+
|Bob         |2011      |28000.00     |1551000.00  |2011-04-16|
|Bob         |2011      |7000.00      |1551000.00  |2011-07-17|
|Mary        |2011      |367000.00    |1551000.00  |2011-04-16|
|Mary        |2011      |556000.00    |1551000.00  |2011-07-15|
|Bob         |2012      |70000.00     |1859000.00  |2012-01-15|
|Bob         |2012      |154000.00    |1859000.00  |2012-04-16|
|Bob         |2012      |107000.00    |1859000.00  |2012-07-16|
...          |          |             |            |          |
+------------+----------+-------------+-----------+----------+
```

Window functions (COUNT)

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       COUNT(CurrentQuota)
       OVER (PARTITION BY SalesYear) AS QuotaPerYear,
       ModifiedDate AS ModDate
FROM SaleGoal
```

```
+------------+----------+------------+--------------+----------+
|SalesPerson |SalesYear |CurrentQuota|QuotaPerYear  | ModDate  |
+------------+----------+------------+--------------+----------+
|Bob         |2011      |28000.00    |4             |2011-04-16|
|Bob         |2011      |7000.00     |4             |2011-07-17|
|Mary        |2011      |367000.00   |4             |2011-04-16|
|Mary        |2011      |556000.00   |4             |2011-07-15|
|Bob         |2012      |70000.00    |8             |2012-01-15|
|Bob         |2012      |154000.00   |8             |2012-04-15|
|Bob         |2012      |107000.00   |8             |2012-10-16|
...
+------------+----------+------------+------------+----------+
```

- Notice the count starts over for each window in column `QuotaPerYear`

Let's practice!

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Common window functions

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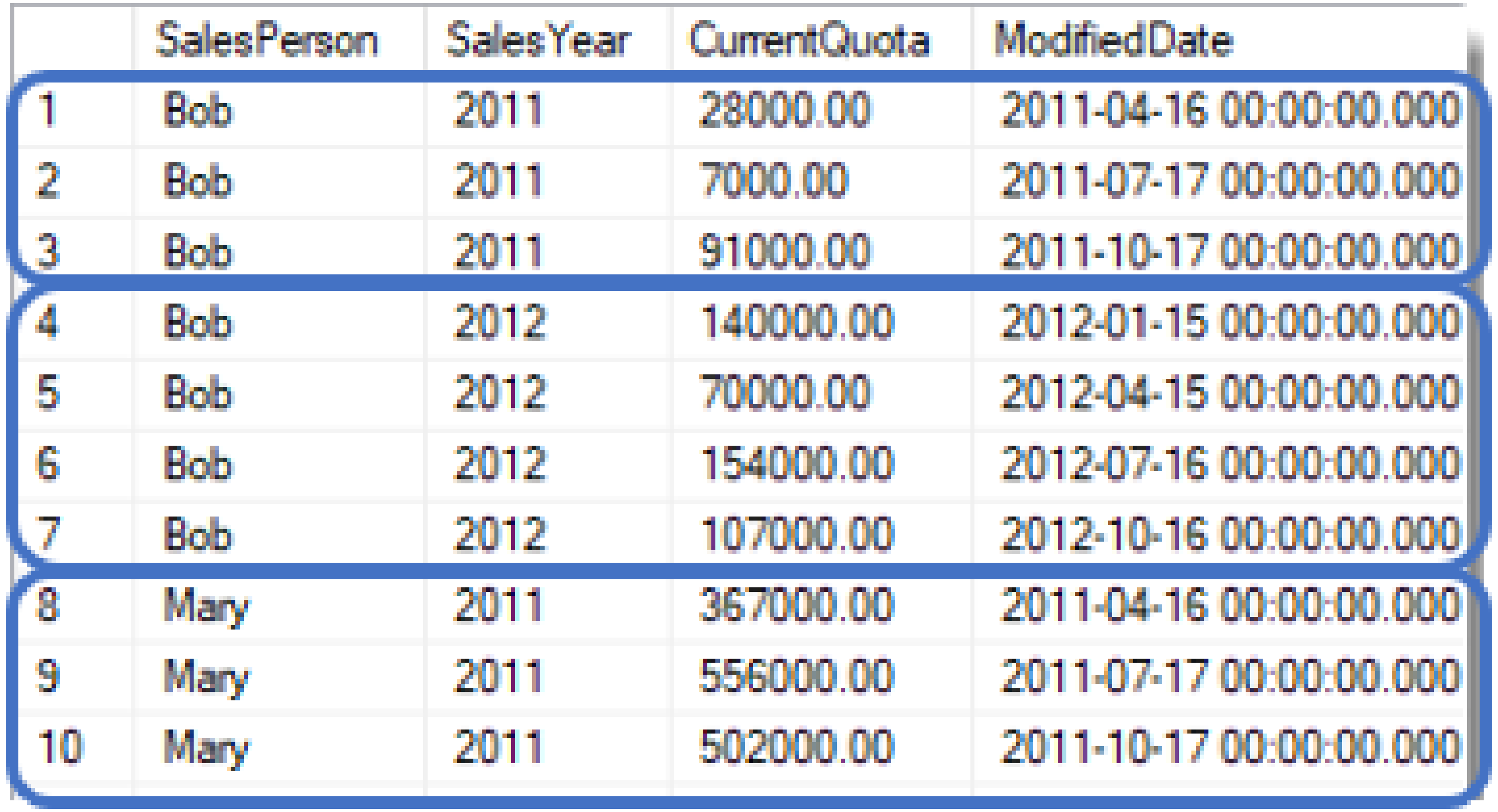
FIRST_VALUE() and LAST_VALUE()

- `FIRST_VALUE()` returns the first value in the window
- `LAST_VALUE()` returns the last value in the window



	SalesPerson	SalesYear	CurrentQuota	ModifiedDate
1	Bob	2011	28000.00	2011-04-16 00:00:00.000
2	Bob	2011	7000.00	2011-07-17 00:00:00.000
3	Bob	2011	91000.00	2011-10-17 00:00:00.000
4	Bob	2012	140000.00	2012-01-15 00:00:00.000
5	Bob	2012	70000.00	2012-04-15 00:00:00.000
6	Bob	2012	154000.00	2012-07-16 00:00:00.000
7	Bob	2012	107000.00	2012-10-16 00:00:00.000
8	Mary	2011	367000.00	2011-04-16 00:00:00.000
9	Mary	2011	556000.00	2011-07-17 00:00:00.000
10	Mary	2011	502000.00	2011-10-17 00:00:00.000

FIRST_VALUE() and LAST_VALUE() in T-SQL

- Note that for FIRST_VALUE and LAST_VALUE the ORDER BY command is required

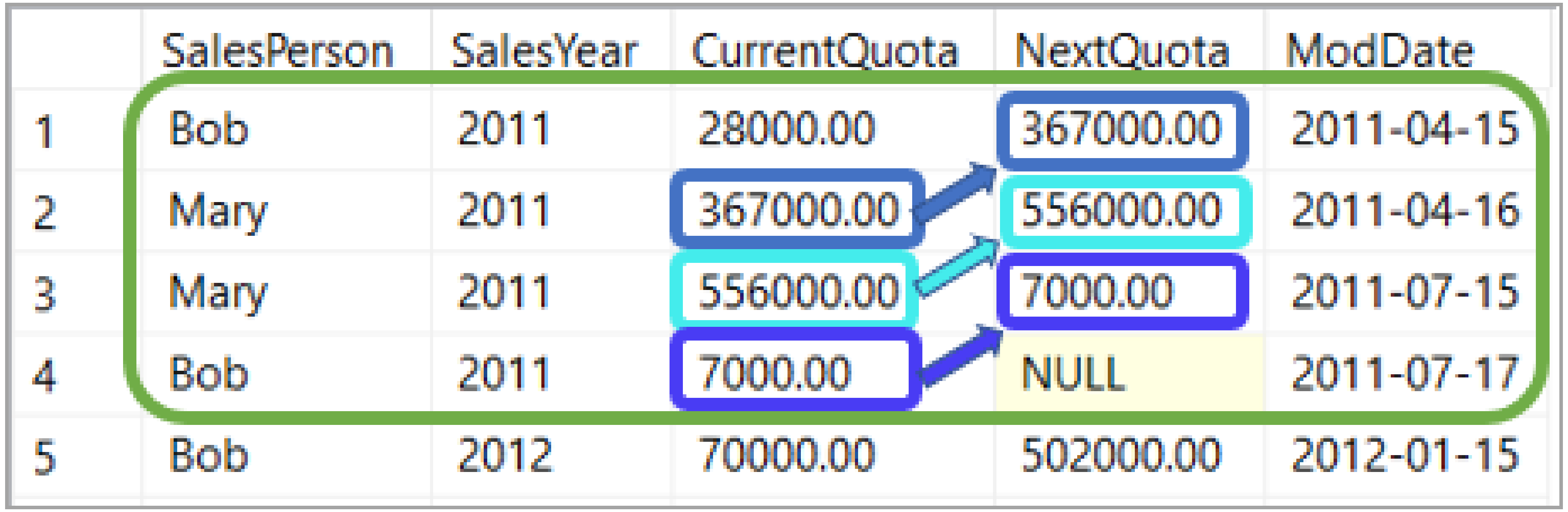
```
-- Select the columns
SELECT SalesPerson, SalesYear, CurrentQuota,
    -- First value from every window
       FIRST_VALUE(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY ModifiedDate) AS StartQuota,
    -- Last value from every window
       LAST_VALUE(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY ModifiedDate) AS EndQuota,
       ModifiedDate as ModDate
FROM SaleGoal
```

Results

```
+------------+----------+------------+----------+----------+----------+
|SalesPerson |SalesYear |CurrentQuota|StartQuota| EndQuota |ModDate   |
+------------+----------+------------+----------+----------+----------+
|Bob         |2011      |28000.00    |28000.00  |91000.00  |2011-04-16|
|Bob         |2011      |7000.00     |28000.00  |91000.00  |2011-07-17|
|Bob         |2011      |91000.00    |28000.00  |91000.00  |2011-10-17|
|Bob         |2012      |140000.00   |140000.00 |107000.00 |2012-01-15|
|Bob         |2012      |70000.00    |140000.00 |107000.00 |2012-04-15|
|Bob         |2012      |154000.00   |140000.00 |107000.00 |2012-07-16|
|Bob         |2012      |107000.00   |140000.00 |107000.00 |2012-10-16|
...
+------------+----------+------------+----------+----------+----------+
```

Getting the next value with LEAD()

- Provides the ability to query the value from the next row
- NextQuota column is created by using `LEAD()`
- Requires the use of `ORDER BY` to order the rows



	SalesPerson	SalesYear	CurrentQuota	NextQuota	ModDate
1	Bob	2011	28000.00	367000.00	2011-04-15
2	Mary	2011	367000.00	556000.00	2011-04-16
3	Mary	2011	556000.00	7000.00	2011-07-15
4	Bob	2011	7000.00	NULL	2011-07-17
5	Bob	2012	70000.00	502000.00	2012-01-15

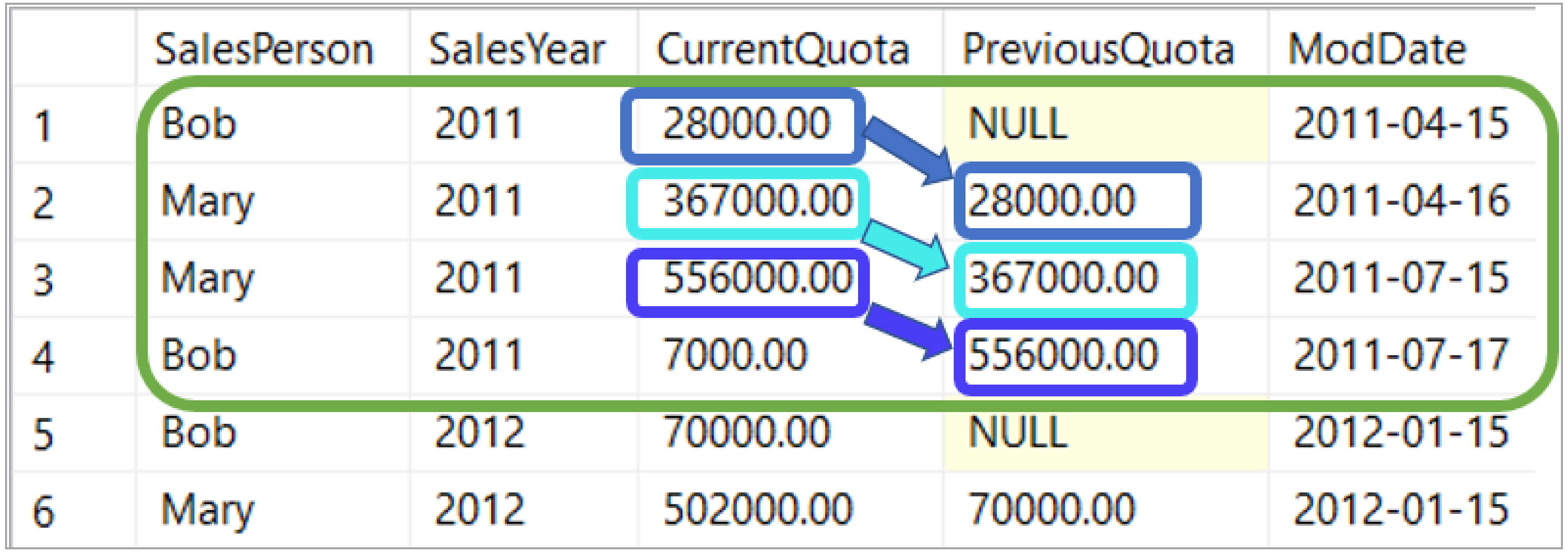
LEAD() in T-SQL

```sql
SELECT SalesPerson, SalesYear, CurrentQuota,
-- Create a window function to get the values from the next row
       LEAD(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY ModifiedDate) AS NextQuota,
       ModifiedDate AS ModDate
FROM SaleGoal
```

```
+------------+----------+------------+------------+----------+
|SalesPerson |SalesYear |CurrentQuota|NextQuota   | ModDate  |
+------------+----------+------------+------------+----------+
|Bob         |2011      |28000.00    |367000.00   |2011-04-15|
|Mary        |2011      |367000.00   |556000.00   |2011-04-16|
|Mary        |2011      |556000.00   |7000.00     |2011-07-15|
|Bob         |2011      |7000.00     |NULL        |2011-07-17|
|Bob         |2012      |70000.00    |502000.00   |2012-01-15|
|Mary        |2012      |502000.00   |154000.00   |2012-01-16|
...
+------------+----------+------------+------------+----------+
```

Getting the previous value with LAG()

- Provides the ability to query the value from the previous row
- PreviousQuota column is created by using `LAG()`
- Requires the use of `ORDER BY` to order the rows



	SalesPerson	SalesYear	CurrentQuota	PreviousQuota	ModDate
1	Bob	2011	28000.00	NULL	2011-04-15
2	Mary	2011	367000.00	28000.00	2011-04-16
3	Mary	2011	556000.00	367000.00	2011-07-15
4	Bob	2011	7000.00	556000.00	2011-07-17
5	Bob	2012	70000.00	NULL	2012-01-15
6	Mary	2012	502000.00	70000.00	2012-01-15

LAG() in T-SQL

```
SELECT SalesPerson, SalesYear, CurrentQuota,
-- Create a window function to get the values from the previous row
       LAG(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY ModifiedDate) AS PreviousQuota,
       ModifiedDate AS ModDate
FROM SaleGoal
```

```
+------------+----------+------------+-------------+----------+
|SalesPerson |SalesYear |CurrentQuota|PreviousQuota |ModDate  |
+------------+----------+------------+-------------+----------+
|Bob         |2011      |28000.00    |NULL         |2011-04-15|
|Mary        |2011      |367000.00   |28000.00     |2011-04-16|
|Mary        |2011      |556000.00   |367000.00    |2011-07-15|
|Bob         |2011      |7000.00.00  |556000.00    |2011-07-17|
|Bob         |2012      |7000.00     |NULL         |2012-01-15|
|Mary        |2012      |502000.00   |7000.00      |2012-01-16|
...
+------------+----------+------------+------------+----------+
```

Let's practice !

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Increasing window complexity

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Reviewing aggregations

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       SUM(CurrentQuota)
       OVER (PARTITION BY SalesYear) AS YearlyTotal,
       ModifiedDate as ModDate
FROM SaleGoal
```

```
+------------+----------+------------+------------+----------+
|SalesPerson |SalesYear |CurrentQuota|YearlyTotal | ModDate  |
+------------+----------+------------+------------+----------+
|Bob         |2011      |28000.00    |1551000.00  |2011-04-16|
|Bob         |2011      |7000.00     |1551000.00  |2011-07-17|
|Bob         |2011      |91000.00    |1551000.00  |2011-10-17|
|Mary        |2011      |140000.00   |1551000.00  |2012-04-15|
|Mary        |2011      |70000.00    |1551000.00  |2012-07-15|
|Mary        |2011      |154000.00   |1551000.00  |2012-01-15|
|Mary        |2012      |107000.00   |1859000.00  |2012-01-16|
...
+------------+----------+------------+------------+----------+
```

Adding ORDER BY to an aggregation

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       SUM(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY SalesPerson) AS YearlyTotal,
       ModifiedDate as ModDate
FROM SaleGoal
```

```
+------------+----------+------------+------------+----------+
|SalesPerson |SalesYear |CurrentQuota|YearTotal   | ModDate  |
+------------+----------+------------+------------+----------+
|Bob         |2011      |28000.00    |35000.00    |2011-04-16|
|Bob         |2011      |7000.00     |35000.00    |2011-07-17|
|Mary        |2011      |367000.00   |958000.00   |2011-10-17|
|Mary        |2011      |556000.00   |958000.00   |2012-04-15|
|Bob         |2012      |70000.00    |401000.00   |2012-07-15|
|Bob         |2012      |154000.00   |401000.00   |2012-10-16|
...
+------------+----------+------------+------------+----------+
```

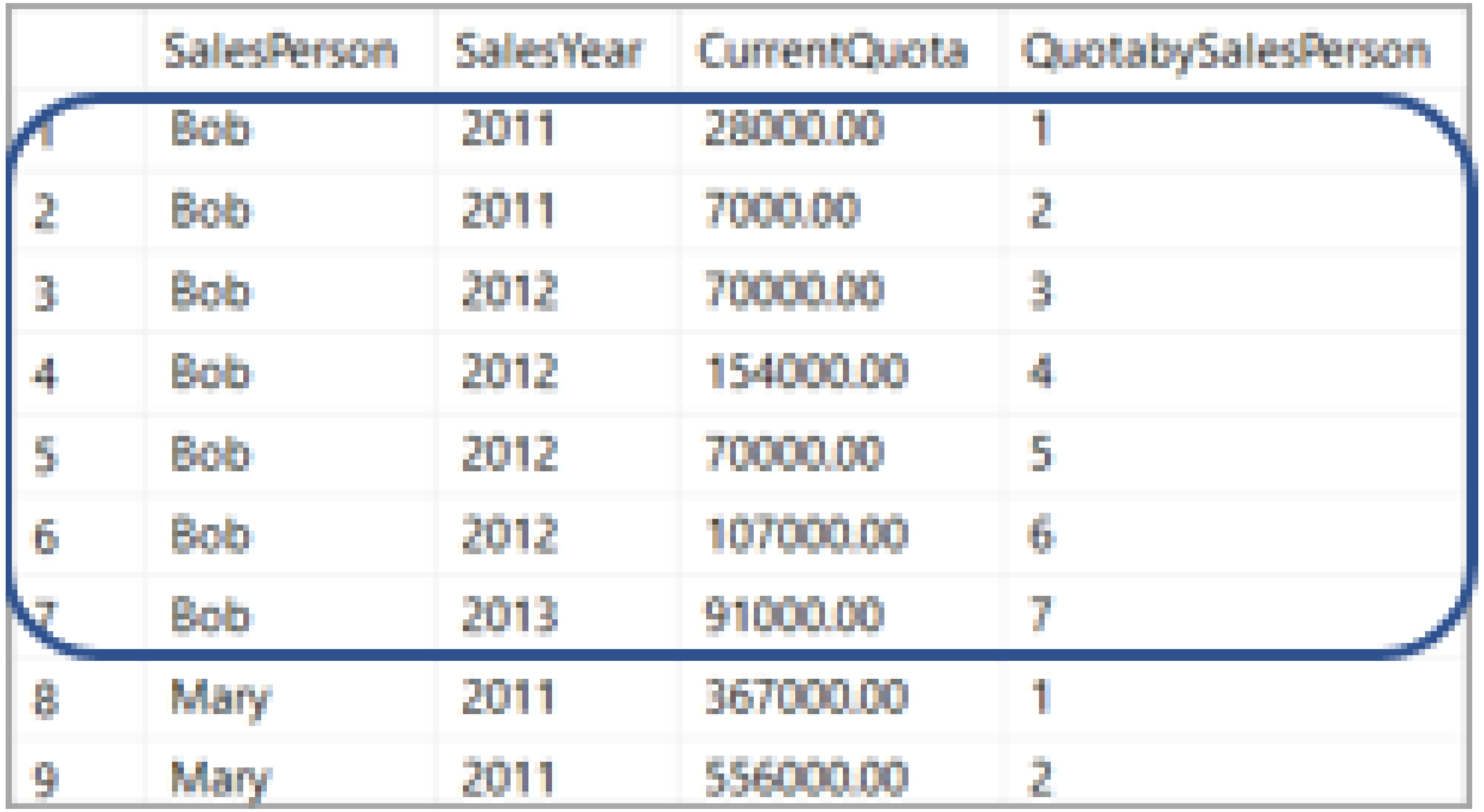
Creating a running total with ORDER BY

```sql
SELECT SalesPerson, SalesYear, CurrentQuota,
       SUM(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY ModifiedDate) as RunningTotal,
       ModifiedDate as ModDate
FROM SaleGoal
```

```
+------------+----------+------------+------------+----------+
|SalesPerson |SalesYear |CurrentQuota|RunningTotal| ModDate  |
+------------+----------+------------+------------+----------+
|Bob         |2011      |28000.00    |28000.00    |2011-04-16|
|Mary        |2011      |367000.00   |395000.00   |2011-07-17|
|Mary        |2011      |556000.00   |951000.00   |2011-10-17|
|Bob         |2011      |7000.00     |958000.00   |2012-04-15|
|Bob         |2012      |70000.00    |70000.00    |2012-01-15|
|Mary        |2012      |502000.00   |572000.00   |2012-01-16|
...
+------------+----------+------------+------------+----------+
```

Adding row numbers

- `ROW_NUMBER()` sequentially numbers the rows in the window
- `ORDER BY` is required when using `ROW_NUMBER()`



	SalesPerson	SalesYear	CurrentQuota	QuotabySalesPerson
1	Bob	2011	28000.00	1
2	Bob	2011	7000.00	2
3	Bob	2012	70000.00	3
4	Bob	2012	154000.00	4
5	Bob	2012	70000.00	5
6	Bob	2012	107000.00	6
7	Bob	2013	91000.00	7
8	Mary	2011	367000.00	1
9	Mary	2011	556000.00	2

Adding row numbers in T-SQL

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       ROW_NUMBER()
       OVER (PARTITION BY SalesPerson ORDER BY SalesYear) AS QuotabySalesPerson
FROM SaleGoal
```

```
+-------------+-----------+------------+------------------+
|SalesPerson  |SalesYear  |CurrentQuota|QuotabySalesPerson|
+-------------+-----------+------------+------------------+
|Bob          |2011       |28000.00    |1                 |
|Bob          |2011       |7000.00     |2                 |
|Bob          |2011       |70000.00    |3                 |
|Bob          |2011       |154000.00   |4                 |
|Bob          |2012       |70000.00    |5                 |
|Bob          |2012       |107000.00   |6                 |
|Bob          |2012       |91000.00    |7                 |
|Mary         |2011       |367000.00   |1                 |
...
+-------------+-----------+------------+------------------+
```

Let's practice!

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Using windows for calculating statistics

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Calculating the standard deviation

- Calculate standard deviation either for the entire table or for each window
- `STDEV()` calculates the standard deviation

Calculating the standard deviation for the entire table

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       STDEV(CurrentQuota)
       OVER () AS StandardDev,
       ModifiedDate  AS ModDate
FROM SaleGoal
```

```
+------------+----------+------------+----------------+----------+
|SalesPerson |SalesYear |CurrentQuota|StandardDev     | ModDate  |
+------------+----------+------------+----------------+----------+
|Bob         |2011      |28000.00    |267841.370964233 |2011-04-16|
|Bob         |2011      |7000.00     |267841.370964233 |2011-07-17|
|Bob         |2011      |91000.00    |267841.370964233 |2011-10-17|
|Bob         |2012      |140000.00   |267841.370964233 |2012-01-15|
|Bob         |2012      |70000.00    |267841.370964233 |2012-04-15|
...
+------------+----------+------------+----------------+----------+
```

Calculating the standard deviation for each partition

```
SELECT SalesPerson, SalesYear, CurrentQuota,
       STDEV(CurrentQuota)
       OVER (PARTITION BY SalesYear ORDER BY SalesYear) AS StDev,
       ModifiedDate AS ModDate
FROM SaleGoal
```

```
+------------+----------+------------+-------------+----------+
|SalesPerson |SalesYear |CurrentQuota|StDev        | ModDate  |
+------------+----------+------------+-------------+----------+
|Bob         |2011      |28000.00    |267841.54080 |2011-04-16|
|Bob         |2011      |7000.00     |267841.54080 |2011-07-17|
|Mary        |2011      |91000.00    |267841.54080 |2011-04-16|
|Mary        |2011      |140000.00   |267841.54080 |2011-07-15|
|Bob         |2012      |70000.00    |246538.86248 |2012-01-15|
|Bob         |2012      |154000.00   |246538.86248 |2012-04-15|
|Bob         |2012      |107000.00   |246538.86248 |2012-07-16|
...
+------------+----------+------------+------------+-----------+
```

Calculating the mode

- Mode is the value which appears the most often in your data
- To calculate mode:
  - Create a CTE containing an ordered count of values using ROW_NUMBER
  - Write a query using the CTE to pick the value with the highest row number

Calculating the mode in T-SQL (I)

```
WITH QuotaCount AS (
SELECT SalesPerson, SalesYear, CurrentQuota,
       ROW_NUMBER()
       OVER (PARTITION BY CurrentQuota ORDER BY CurrentQuota) AS QuotaList
FROM SaleGoal
)
SELECT * FROM QuotaCount
```

```
+------------+----------+------------+-------------+
|SalesPerson |SalesYear |CurrentQuota|QuotaList    |
+------------+----------+------------+-------------+
|Bob         |2011      |7000.00     |1            |
|Bob         |2011      |28000.00    |1            |
|Bob         |2011      |70000.00    |1            |
|Bob         |2012      |70000.00    |2            |
|Mary        |2012      |73000.00    |1            |
...
+------------+----------+------------+-------------+
```

- Notice there are two values for 70,000.00

Calculating the mode in T-SQL (II)

```
WITH QuotaCount AS (
SELECT SalesPerson, SalesYear, CurrentQuota,
       ROW_NUMBER()
       OVER (PARTITION BY CurrentQuota ORDER BY CurrentQuota) AS QuotaList
FROM SaleGoal
)

SELECT CurrentQuota, QuotaList AS Mode
FROM QuotaCount
WHERE QuotaList IN (SELECT  MAX(QuotaList) FROM QuotaCount)
```

```
+------------+----------+
|CurrentQuota|Mode      |
+------------+----------+
|70000.00    |2         |
+------------+----------+
```

Let's practice!

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