Introduction

POSTGRESQL SUMMARY STATS AND WINDOW FUNCTIONS

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Motivation

USA total and running total of Summer Olympics gold medals since 2004

Year	Medals	Medals_RT
2004	116	116
2008	125	241
2012	147	388

Discus throw reigning champion status

Year	Champion	Last_Champion	Reigning_Champion
1996	GER	null	false
2000	LTU	GER	false
2004	LTU	LTU	true
2008	EST	LTU	false
2012	GER	EST	false

Course outline

1. Introduction to window functions
2. Fetching, ranking, and paging
3. Aggregate window functions and frames
4. Beyond window functions

Summer olympics dataset

- Each row represents a medal awarded in the Summer Olympics games

Columns

- `Year`, `City`
- `Sport`, `Discipline`, `Event`
- `Athlete`, `Country`, `Gender`
- `Medal`

Window functions

- Perform an operation across a set of rows that are somehow related to the current row
- Similar to `GROUP BY` aggregate functions, but all rows remain in the output

Uses

- Fetching values from preceding or following rows (e.g. fetching the previous row's value)
  - Determining reigning champion status
  - Calculating growth over time
- Assigning ordinal ranks (1rst, 2nd, *etc.*) to rows based on their values' positions in a sorted list
- Running totals, moving averages

Row numbers

Query

```
SELECT
  Year, Event, Country
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

Result

```
| Year | Event                        | Country |
|------|------------------------------|---------|
| 1896 | 100M Freestyle               | HUN     |
| 1896 | 100M Freestyle For Sailors | GRE     |
| 1896 | 1200M Freestyle              | HUN     |
| ...  | ...                          | ...     |
```

Enter ROW_NUMBER

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER () AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

Result

Year	Event	Country	Row_N
1896	100M Freestyle	HUN	1
1896	100M Freestyle For Sailors	GRE	2
1896	1200M Freestyle	HUN	3
...	...	...	...

Anatomy of a window function

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER () AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

- `FUNCTION_NAME() OVER (...)`
  - `ORDER BY`
  - `PARTITION BY`
  - `ROWS/RANGE PRECEDING/FOLLOWING/UNBOUNDED`

Let's practice!

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ORDER BY

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Row numbers

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER () AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

Result*

Year	Event	Country	Row_N
1896	100M Freestyle	HUN	1
1896	100M Freestyle For Sailors	GRE	2
1896	1200M Freestyle	HUN	3
...	...	...	...

Enter ORDER BY

- `ORDER BY` in `OVER` orders the rows related to the current row
  - **Example:** Ordering by year in descending order in `ROW_NUMBER` 's `OVER` clause will assign 1 to the most recent year's rows

Ordering by Year in descending order

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER (ORDER BY Year DESC) AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

Result

Year	Event	Country	Row_N
2012	Wg 96 KG	IRI	1
2012	4X100M Medley	USA	2
2012	Wg 84 KG	RUS	3
...	...	...	...
2008	50M Freestyle	BRA	637
2008	96 - 120KG	CUB	638
...	...	...	...

Ordering by multiple columns

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER
    (ORDER BY Year DESC, Event ASC) AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold';
```

Result

```
| Year | Event    | Country | Row_N |
|------|----------|---------|-------|
| 2012 | + 100KG  | FRA     | 1     |
| 2012 | + 67 KG  | SRB     | 2     |
| 2012 | + 78KG   | CUB     | 3     |
| ...  | ...      | ...     | ...   |
```

Ordering in- and outside OVER

Query

```
SELECT
  Year, Event, Country,
  ROW_NUMBER() OVER
    (ORDER BY Year DESC, Event ASC) AS Row_N
FROM Summer_Medals
WHERE
  Medal = 'Gold'
ORDER BY Country ASC, Row_N ASC;
```

Result

```
| Year | Event   | Country | Row_N |
|------|---------|---------|-------|
| 2012 | 1500M   | ALG     | 36    |
| 2000 | 1500M   | ALG     | 1998  |
| 1996 | 1500M   | ALG     | 2662  |
| ...  | ...     | ...     | ...   |
```

- `ORDER BY` inside `OVER` takes effect before `ORDER BY` outside `OVER`

Reigning champion

- A reigning champion is a champion who's won both the previous and current years' competitions
- The previous and current year's champions need to be in the same row (in two different columns)

Enter LAG

- `LAG(column, n) OVER (...)` returns `column` 's value at the row `n` rows before the current row
  - `LAG(column, 1) OVER (...)` returns the previous row's value

Current champions

Query

```
SELECT
  Year, Country AS Champion
FROM Summer_Medals
WHERE
  Year IN (1996, 2000, 2004, 2008, 2012)
  AND Gender = 'Men' AND Medal = 'Gold'
  AND Event = 'Discus Throw';
```

Result

```
| Year | Champion |
|------|----------|
| 1996 | GER      |
| 2000 | LTU      |
| 2004 | LTU      |
| 2008 | EST      |
| 2012 | GER      |
```

Current and last champions

Query

```
WITH Discus_Gold AS (
  SELECT
    Year, Country AS Champion
  FROM Summer_Medals
  WHERE
    Year IN (1996, 2000, 2004, 2008, 2012)
    AND Gender = 'Men' AND Medal = 'Gold'
    AND Event = 'Discus Throw')

SELECT
  Year, Champion,
  LAG(Champion, 1) OVER
    (ORDER BY Year ASC) AS Last_Champion
FROM Discus_Gold
ORDER BY Year ASC;
```

Result

```
| Year | Champion | Last_Champion |
|------|----------|---------------|
| 1996 | GER      | null          |
| 2000 | LTU      | GER           |
| 2004 | LTU      | LTU           |
| 2008 | EST      | LTU           |
| 2012 | GER      | EST           |
```

Let's practice!

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PARTITION BY

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Motivation

Query

```
WITH Discus_Gold AS (
  SELECT
    Year, Event, Country AS Champion
  FROM Summer_Medals
  WHERE
    Year IN (2004, 2008, 2012)
    AND Gender = 'Men' AND Medal = 'Gold'
    AND Event IN ('Discus Throw', 'Triple Jump')
    AND Gender = 'Men')

SELECT
  Year, Event, Champion,
  LAG(Champion) OVER
    (ORDER BY Event ASC, Year ASC) AS Last_Champion
FROM Discus_Gold
ORDER BY Event ASC, Year ASC;
```

Result

```
| Year | Event         | Champion | Last_Champion |
|------|---------------|----------|---------------|
| 2004 | Discus Throw  | LTU      | null          |
| 2008 | Discus Throw  | EST      | LTU           |
| 2012 | Discus Throw  | GER      | EST           |
| 2004 | Triple Jump   | SWE      | GER           |
| 2008 | Triple Jump   | POR      | SWE           |
| 2012 | Triple Jump   | USA      | POR           |
```

- When `Event` changes from `Discus Throw` to `Triple Jump`, `LAG` fetched `Discus Throw`'s last champion as opposed to a `null`

Enter PARTITION BY

- `PARTITION BY` splits the table into partitions based on a column's unique values
  - The results aren't rolled into one column
- Operated on separately by the window function
  - `ROW_NUMBER` will reset for each partition
  - `LAG` will only fetch a row's previous value if its previous row is in the same partition

Partitioning by one column

Query

```
WITH Discus_Gold AS (...)

SELECT
  Year, Event, Champion,
  LAG(Champion) OVER
    (PARTITION BY Event
     ORDER BY Event ASC, Year ASC) AS Last_Champion
FROM Discus_Gold
ORDER BY Event ASC, Year ASC;
```

Result

Year	Event	Champion	Last_Champion
2004	Discus Throw	LTU	null
2008	Discus Throw	EST	LTU
2012	Discus Throw	GER	EST
2004	Triple Jump	SWE	null
2008	Triple Jump	POR	SWE
2012	Triple Jump	USA	POR

More complex partitioning

Year	Country	Event	Row_N
2008	CHN	+ 78KG (Heavyweight)	1
2008	CHN	- 49 KG	2
...	...	...	...
2008	JPN	48 - 55KG	27
2008	JPN	48 - 55KG	28
...	...	...	...
2012	CHN	+75KG	32
2012	CHN	- 49 KG	33
...	...	...	...
2012	JPN	+75KG	51
2012	JPN	- 49 KG	52
...	...	...	...

- Row number should reset per `Year` and `Country`

Partitioning by multiple columns

Query

```
WITH Country_Gold AS (
  SELECT
    DISTINCT Year, Country, Event
  FROM Summer_Medals
  WHERE
    Year IN (2008, 2012)
    AND Country IN ('CHN', 'JPN')
    AND Gender = 'Women' AND Medal = 'Gold')

SELECT
  Year, Country, Event,
  ROW_NUMBER() OVER (PARTITION BY Year, Country)
FROM Country_Gold;
```

Result

Year	Country	Event	Row_N
2008	CHN	+ 78KG (Heavyweight)	1
2008	CHN	- 49 KG	2
...	...	...	...
2008	JPN	48 - 55KG	1
2008	JPN	48 - 55KG	2
...	...	...	...
2012	CHN	+75KG	1
2012	CHN	- 49 KG	2
...	...	...	...
2012	JPN	+75KG	1
2012	JPN	- 49 KG	2
...	...	...	...

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