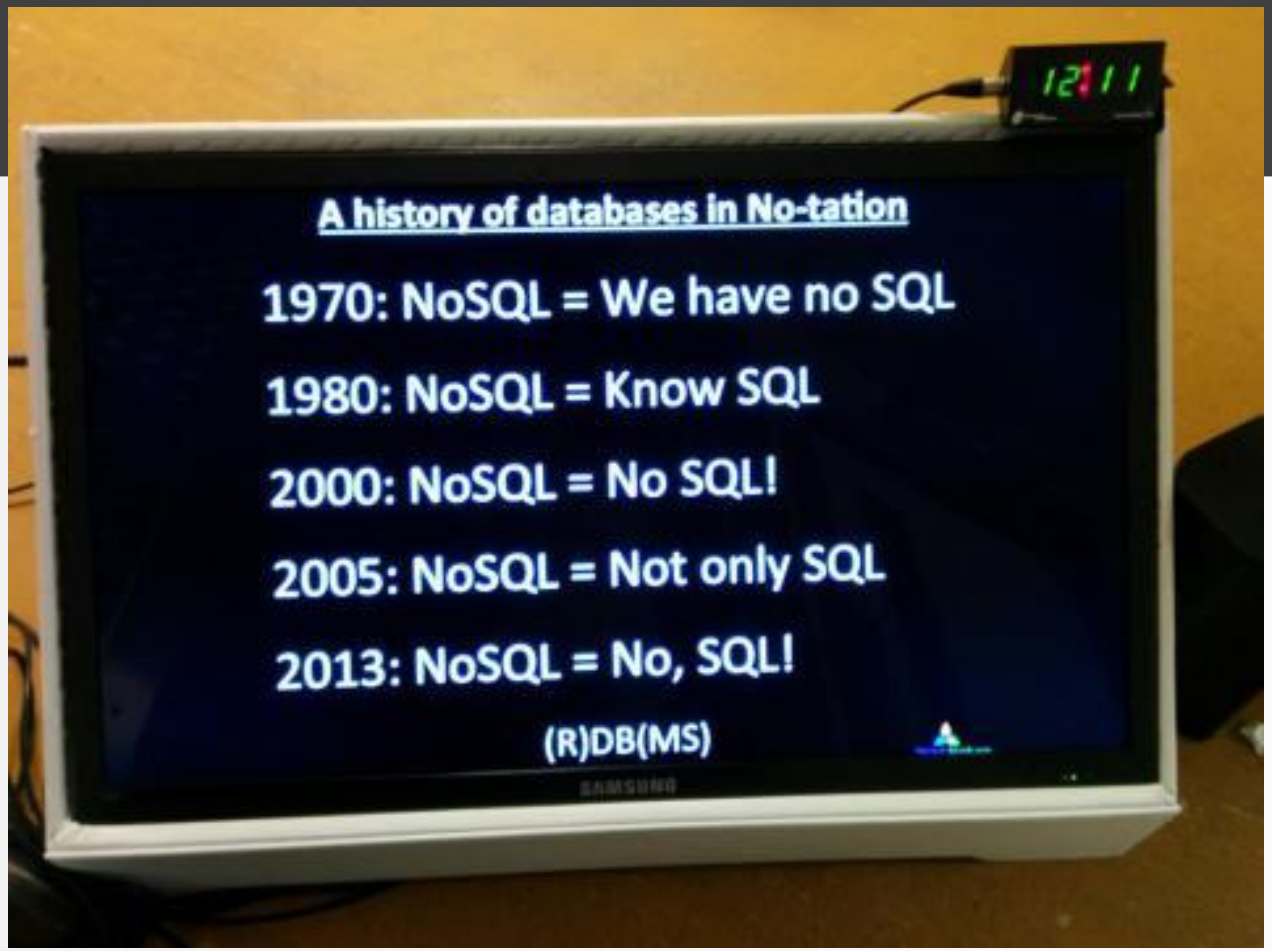
SQL, the underestimated “Big Data” technology

No – tation



Seen at the 2013 O'Reilly Strata Conf:
History of NoSQL by Mark Madsen. Picture published by Edd Dumbill

NoSQL?

NoSQL?

No, SQL!

Our vision at Data Geekery

- SQL dominates database systems
- SQL is very expressive
- SQL is very type safe

> “SQL is a device whose mystery is only exceeded by its power!”

Me – @lukaseder

- Head of R&D at Data Geekery GmbH
- SQL Aficionado
- Java Aficionado

> “Java developers can get back in control of SQL with jOOQ”

Big Data? NoSQL?

- You're giving up on **ACID**
- You're giving up on **type safety**
- You're giving up on **standards**
- You're giving up on **tooling**
- You're giving up on **relational algebra**
- You haven't asked operations
- You don't actually have «Big Data»

Big Data? NoSQL?

- You're giving up on **ACID**
- You're giving up on **type safety**
- You're giving up on **standards**
- You're giving up on **tooling**
- You're giving up on **relational algebra**
- You haven't asked operations
- You don't actually have «Big Data»

Also Not SQL

```
@Entity @Table(name = "EVENTS")
public class Event {
  private Long id;
  private String title;
  private Date date;

  @Id @GeneratedValue(generator = "increment")
  @GenericGenerator(name = "increment", strategy = "increment")
  public Long getId() { /* … */ }

  @Temporal(TemporalType.TIMESTAMP)
  @Column(name = "EVENT_DATE")
  public Date getDate() { /* … */ }
```

Also Not SQL – Annotatiomania™

```
@OneToMany(mappedBy = "destCustomerId")
@ManyToMany
@Fetch(FetchMode.SUBSELECT)
@JoinTable(
    name = "customer_dealer_map",
    joinColumns = {
        @JoinColumn(name = "customer_id", referencedColumnName = "id")
    },
    inverseJoinColumns = {
        @JoinColumn(name = "dealer_id", referencedColumnName = "id")
    }
)
private Collection dealers;
```

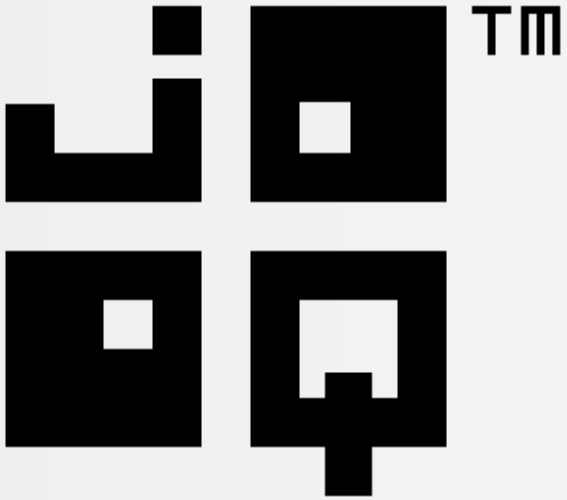
Found at http://stackoverflow.com/q/17491912/521799

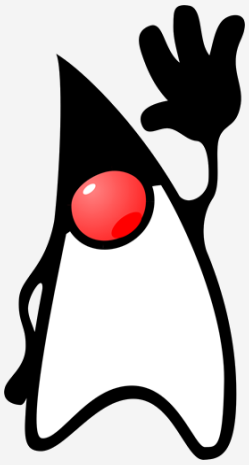
Also Not SQL – JPA 3.0 Preview

```
@OneToMany @OneToManyMore @AnyOne @AnyBody
@ManyToMany @Many
@Fetch @FetchMany @FetchWithDiscriminator(name = "no_name")
@JoinTable(joinColumns = {
    @JoinColumn(name = "customer_id", referencedColumnName = "id")
})
@PrefetchJoinWithDiscriminator
@IfJoiningAvoidHashJoins @ButUseHashJoinsWhenMoreThan(records = 1000)
@XmlDataTransformable @SpringPrefechAdapter
private Collection employees;
```

Might not be true

Shocker! You can now write SQL in Java.

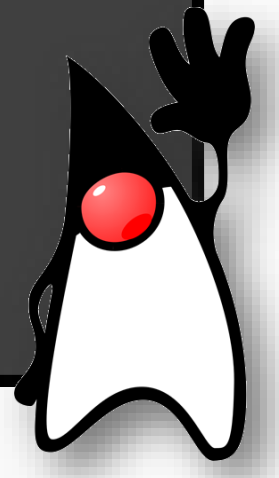




SQL in Java 7 – JDBC

```
try (PreparedStatement stmt = c.prepareStatement(sql);
     ResultSet rs           = stmt.executeQuery()) {

    while (rs.next()) {
        System.out.println(
            new Schema(rs.getString("SCHEMA_NAME"),
                       rs.getBoolean("IS_DEFAULT"))
        );
    }
}
```



SQL in Java 8 – jOOQ

```
DSL.using(c)
   .fetch(sql)
   .map(rs -> new Schema(
        rs.getValue("SCHEMA_NAME", String.class),
        rs.getValue("IS_DEFAULT", boolean.class)
   ))
   .forEach(System.out::println);
```

Typesafe SQL in Java – jOOQ

```
DSL.using(c)
   .select(s.SCHEMA_NAME, s.IS_DEFAULT)
   .from(INFORMATION_SCHEMA.SCHEMATA.as("s"))
   .orderBy(s.SCHEMA_NAME)
   .map(rs -> new Schema(
        rs.getValue(s.SCHEMA_NAME),
        rs.getValue(s.IS_DEFAULT)
   ))
   .forEach(System.out::println);
```

SQL in Java 8 – Spring JDBC

```
new JdbcTemplate(
        new SingleConnectionDataSource(c, true))
    .query(sql, (rs, rowNum) ->
        new Schema(
            rs.getString("SCHEMA_NAME"),
            rs.getBoolean("IS_DEFAULT")
        ))
    .forEach(System.out::println);
```

SQL in Java 8 – Apache DbUtils

```
new QueryRunner()
    .query(c, sql, new ArrayListHandler())
    .stream()
    .map(array -> new Schema(
        (String) array[0],
        (Boolean) array[1]
    ))
    .forEach(System.out::println);
```

SQL in Groovy

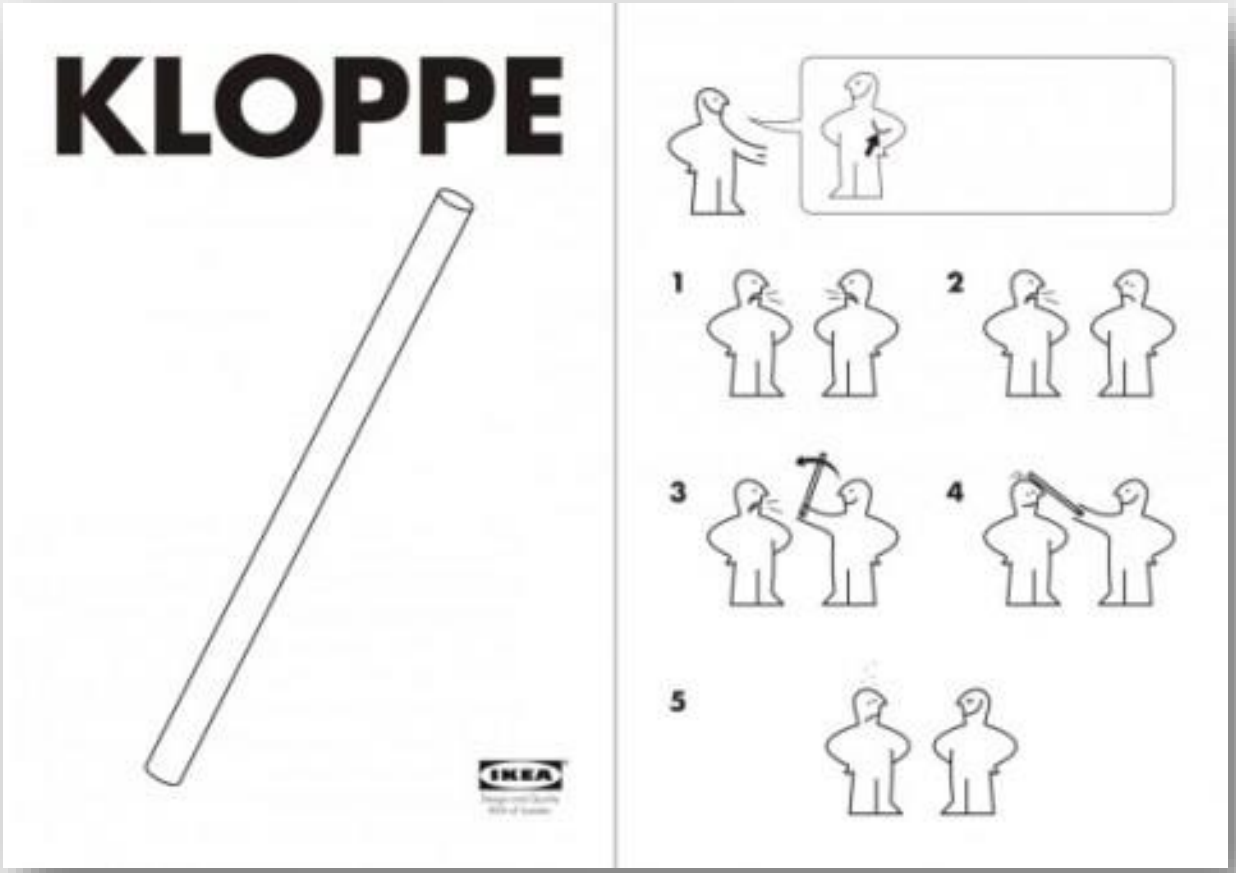
```
sql.eachRow( 'select * from tableName' ) {
    println "$it.id -- ${it.firstName} --"
}
```

When you should use SQL – indicators

- You need JOINs, UNIONs
- You need functions, aggregations
- You need bulk reads / writes

> “Calculations should be done close to the data”

Please, run that calculation in your DB



SQL Trivia – NULL

```
-- What does this query return?
SELECT 1 AS a FROM dual
WHERE 1 IN (NULL)
UNION ALL
SELECT 2 AS a FROM dual
WHERE NOT(1 IN (NULL))
```

SQL Trivia – NULL

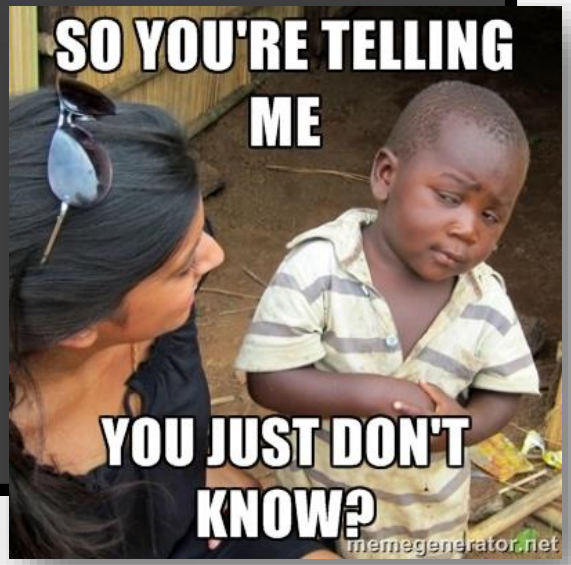
```
-- What does this query return?
SELECT 1 AS a FROM dual
WHERE 1 IN (NULL)
UNION ALL
SELECT 2 AS a FROM dual
WHERE NOT(1 IN (NULL))
```

SQL Trivia – NULL

```
-- Nothing! It's the same as this
SELECT 1 AS a FROM dual
WHERE  1 = NULL
UNION ALL
SELECT 2 AS a FROM dual
WHERE  1 != NULL
```

SQL Trivia – NULL

```
-- Nothing! It’s the same as this
SELECT 1 AS a FROM dual
WHERE “UNKNOWN”
UNION ALL
SELECT 2 AS a FROM dual
WHERE “UNKNOWN”
```



SQL Trivia – Oracle VARCHAR2

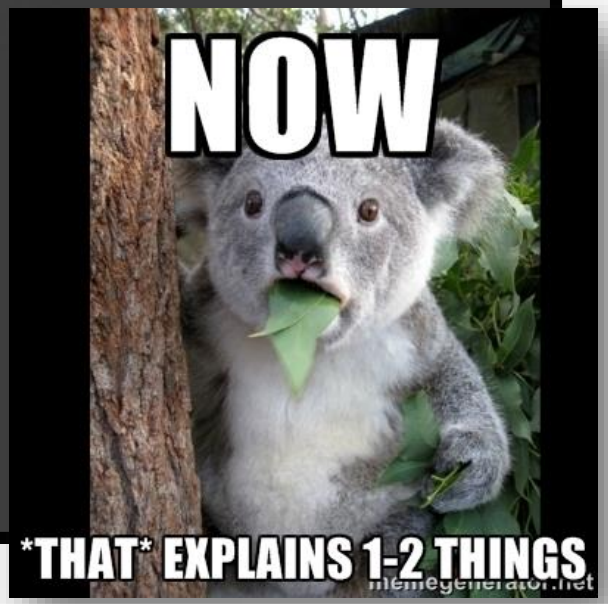
```
-- What does this query return?
SELECT 1 AS a FROM dual
WHERE '' = ''
UNION ALL
SELECT 2 AS a FROM dual
WHERE 'a' != ''
```

SQL Trivia – Oracle VARCHAR2

```
-- Nope! Nothing again (only in Oracle).
SELECT 1 AS a FROM dual
WHERE NULL = NULL
UNION ALL
SELECT 2 AS a FROM dual
WHERE 'a' != NULL
```

SQL Trivia – Oracle VARCHAR2

```
-- Nope! Nothing again (only in Oracle).
SELECT 1 AS a FROM dual
WHERE NULL = NULL
UNION ALL
SELECT 2 AS a FROM dual
WHERE 'a' != NULL
```



Stockholm Syndrome:

> “We love ~~JavaScript~~ SQL”

Winston Churchill:

> “SQL is the worst form of database querying, except for all the other forms.”

Let's calculate a running total

```
SELECT   *
FROM     v_transactions
WHERE    account_id = 1
ORDER BY value_date DESC,
         id         DESC
```

Let’s calculate a running total

ID	VALUE_DATE	AMOUNT
9997	2014-03-18	99.17
9981	2014-03-16	71.44
9979	2014-03-16	-94.60
9977	2014-03-16	-6.96
9971	2014-03-15	-65.95

Let's calculate a running total

ID	VALUE_DATE	AMOUNT	BALANCE
9997	2014-03-18	99.17	19985.81
9981	2014-03-16	71.44	19886.64
9979	2014-03-16	-94.60	19815.20
9977	2014-03-16	-6.96	19909.80
9971	2014-03-15	-65.95	19916.76

Let's calculate a running total

ID	VALUE_DATE	AMOUNT	BALANCE
9997	2014-03-18	+99.17	=19985.81
9981	2014-03-16	71.44	+19886.64
9979	2014-03-16	-94.60	19815.20
9977	2014-03-16	-6.96	19909.80
9971	2014-03-15	-65.95	19916.76

Let's calculate a running total

ID	VALUE_DATE	AMOUNT	BALANCE
9997	2014-03-18	99.17	19985.81
9981	2014-03-16	+71.44	=19886.64
9979	2014-03-16	-94.60	+19815.20
9977	2014-03-16	-6.96	19909.80
9971	2014-03-15	-65.95	19916.76

Let's calculate a running total

ID	VALUE_DATE	AMOUNT	BALANCE	
9997	2014-03-18	99.17	19985.81	
9981	2014-03-16	+71.44	=19886.64	n
9979	2014-03-16	-94.60	+19815.20	n+1
9977	2014-03-16	-6.96	19909.80	

$$BALANCE(ROW_n) = BALANCE(ROW_{n+1}) + AMOUNT(ROW_n)$$

$$BALANCE(ROW_{n+1}) = BALANCE(ROW_n) - AMOUNT(ROW_n)$$

“How can we do it?”

How can we do it?

- In Java
- Calculate on UPDATE
- Nested SELECT
- Recursive SQL
- Window functions
- MODEL clause (Oracle)
- Stored procedures

How can we do it? – With SQL!

- ~~In Java~~
- ~~Calculate on UPDATE~~
- Nested SELECT
- Recursive SQL
- Window functions
- MODEL clause (Oracle)
- ~~Stored procedures~~

“Using nested SELECTs”


```
SELECT
  t1.*,
  t1.current_balance - (
    SELECT NVL(SUM(amount), 0)
    FROM   v_transactions t2
    WHERE  t2.account_id = t1.account_id
    AND   (t2.value_date, t2.id) >
          (t1.value_date, t1.id)
  ) AS balance
FROM     v_transactions t1
WHERE    t1.account_id = 1
ORDER BY t1.value_date DESC, t1.id DESC
```

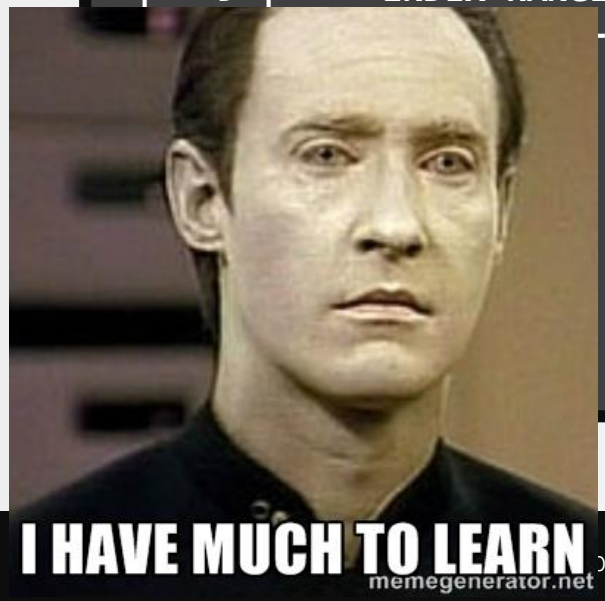
```
SELECT
  t1.*,
  t1.current_balance - (
    SELECT NVL(SUM(amount), 0)
    FROM   v_transactions t2
    WHERE  t2.account_id = t1.account_id
    AND    (t2.value_date, t2.id) >
           (t1.value_date, t1.id)
  ) AS balance
FROM     v_transactions t1
WHERE    t1.account_id = 1
ORDER BY t1.value_date DESC, t1.id DESC
```

```
SELECT
  t1.*,
  t1.current_balance - (
    SELECT NVL(SUM(amount), 0)
    FROM   v_transactions t2
    WHERE  t2.account_id = t1.account_id
    AND    ((t2.value_date > t1.value_date) OR
            (t2.value_date = t1.value_date AND
             t2.id         > t1.id))
  ) AS balance
FROM     v_transactions t1
WHERE    t1.account_id = 1 ORDER BY ...
```

Using nested SELECTs

ID	VALUE_DATE	AMOUNT	BALANCE
9997	2014-03-18	-(99.17)	+19985.81
9981	2014-03-16	-(71.44)	19886.64
9979	2014-03-16	-(-94.60)	19815.20
9977	2014-03-16	-6.96	=19909.80
9971	2014-03-15	-65.95	19916.76

```
| Id  | Operation                    | Name           | A-Rows |   A-Time   |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |                |     50 |00:00:00.77 |
|   1 |  SORT AGGREGATE              |                |   1101 |00:00:00.76 |
|*  2 |   TABLE ACCESS BY INDEX ROWID| T_TRANSACTIONS |    605K|00:00:00.69 |
|*  3 |    INDEX RANGE SCAN          | I_TRX_ACCO_ID  |   1212K|00:00:00.21 |
|   4 |  SORT ORDER BY               |                |     50 |00:00:00.77 |
|   5 |   NESTED LOOPS               |                |   1101 |00:00:00.01 |
|   6 |    TABLE ACCESS BY INDEX ROWID| T_ACCOUNTS     |      1 |00:00:00.01 |
|*  7 |     INDEX UNIQUE SCAN        | SYS_C006991    |      1 |00:00:00.01 |
|   8 |    TABLE ACCESS BY INDEX ROWID| T_TRANSACTIONS |   1101 |00:00:00.01 |
|*  9 |     INDEX RANGE SCAN         | I_TRX_ACCO_ID  |   1101 |00:00:00.01 |
-------------------------------------------------------------------------------
```



“Using recursive SQL”

We need to number transactions

ID	VALUE_DATE	AMOUNT	TRANSACTION_NR
9997	2014-03-18	99.17	1
9981	2014-03-16	71.44	2
9979	2014-03-16	-94.60	3
9977	2014-03-16	-6.96	4
9971	2014-03-15	-65.95	5

```
CREATE OR REPLACE VIEW v_transactions_by_time
AS
SELECT
  t.*,
  ROW_NUMBER() OVER (
    PARTITION BY account_id
    ORDER BY     t.value_date DESC,
                 t.id DESC
  ) AS transaction_number
FROM
  v_transactions t;
```


```
WITH ordered_with_balance (
  account_id, value_date, amount, balance, transaction_number
)
AS (
  SELECT t1.account_id, t1.value_date, t1.amount, t1.current_balance,
         t1.transaction_number
  FROM   v_transactions_by_time t1
  WHERE  t1.transaction_number = 1

  UNION ALL

  SELECT t1.account_id, t1.value_date, t1.amount, t2.balance - t2.amount,
         t1.transaction_number
  FROM   ordered_with_balance t2
  JOIN   v_transactions_by_time t1
  ON     t1.transaction_number = t2.transaction_number + 1
  AND    t1.account_id = t2.account_id
)
SELECT *
FROM     ordered_with_balance
WHERE    account_id = 1
ORDER BY transaction_number ASC
```

```
WITH ordered_with_balance (
  account_id, value_date, amount, balance, transaction_number
)
AS (
  SELECT t1.account_id, t1.value_date, t1.amount, t1.current_balance,
         t1.transaction_number
  FROM   v_transactions_by_time t1
  WHERE  t1.transaction_number = 1

  UNION ALL

  SELECT t1.account_id, t1.value_date, t1.amount, t2.balance - t2.amount,
         t1.transaction_number
  FROM   ordered_with_balance t2
  JOIN   v_transactions_by_time t1
  ON     t1.transaction_number = t2.transaction_number + 1
  AND    t1.account_id = t2.account_id
)
SELECT *
FROM     ordered_with_balance
WHERE    account_id = 1
ORDER BY transaction number ASC
```

```
WITH ordered_with_balance (
  account_id, value_date, amount, balance, transaction_number
)
AS (
  SELECT t1.account_id, t1.value_date, t1.amount, t1.current_balance,
         t1.transaction_number
  FROM   v_transactions_by_time t1
  WHERE  t1.transaction_number = 1

  UNION ALL

  SELECT t1.account_id, t1.value_date, t1.amount, t2.balance - t2.amount,
         t1.transaction_number
  FROM   ordered_with_balance t2
  JOIN   v_transactions_by_time t1
  ON     t1.transaction_number = t2.transaction_number + 1
  AND    t1.account_id = t2.account_id
)
SELECT *
FROM     ordered_with_balance
WHERE    account_id = 1
ORDER BY transaction_number ASC
```

Id	Operation	Name	A-Rows	A-Time
0	SELECT STATEMENT		50	00:00:35.29
1	SORT ORDER BY		50	00:00:35.29
* 2	VIEW		1101	00:00:35.29
3	UNION ALL (RECURSIVE WITH) BREADTH FIRST		9999	00:00:35.28
* 4	VIEW	V_TRANSACTIONS_BY_TIME	9	00:00:00.03
* 5	WINDOW SORT PUSHED RANK		18	00:00:00.03
6	NESTED LOOPS		9999	00:00:00.01
7	NESTED LOOPS		9999	00:00:00.01
8	TABLE ACCESS FULL	T_ACCOUNTS	10	00:00:00.01
* 9	INDEX RANGE SCAN	I_TRX_ACCO_ID	9999	00:00:00.01
10	TABLE ACCESS BY INDEX ROWID	T_TRANSACTIONS	9999	00:00:00.01
* 11	HASH JOIN		9990	00:00:35.08
12	VIEW	V_TRANSACTIONS_BY_TIME	11M	00:00:29.13
13	WINDOW SORT		11M	00:00:27.19
14	NESTED LOOPS		11M	00:00:13.62
15	NESTED LOOPS		11M	00:00:03.89
16	INDEX FAST FULL SCAN	SYS_C006991	11450	00:00:00.06
* 17	INDEX RANGE SCAN	I_TRX_ACCO_ID	11M	00:00:02.18
18	TABLE ACCESS BY INDEX ROWID	T_TRANSACTIONS	11M	00:00:06.15
	PUMP		9999	00:00:00.01

“Using window functions”

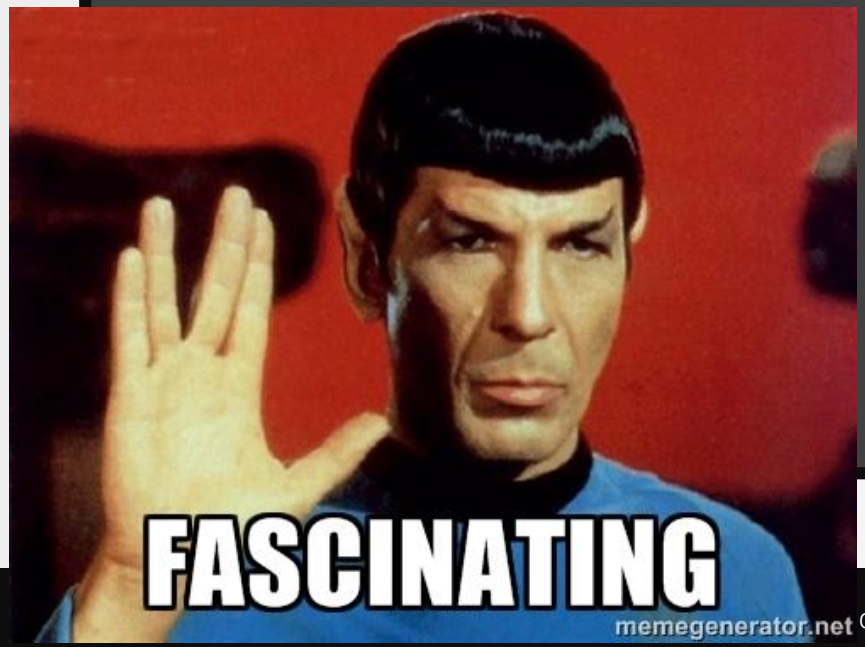

```
SELECT
  t.*,
  t.current_balance - NVL(
    SUM(t.amount) OVER (
      PARTITION BY t.account_id
      ORDER BY     t.value_date DESC,
                   t.id         DESC
      ROWS BETWEEN UNBOUNDED PRECEDING
           AND     1         PRECEDING
    ),
  0) AS balance
FROM     v_transactions t
WHERE    t.account_id = 1
ORDER BY t.value_date DESC,
         t.id         DESC
```

```
SELECT
  t.*,
  t.current_balance - NVL(
    SUM(t.amount) OVER (
      PARTITION BY t.account_id
      ORDER BY     t.value_date DESC,
                   t.id         DESC
      ROWS BETWEEN UNBOUNDED PRECEDING
           AND     1         PRECEDING
    ),
  0) AS balance
FROM     v_transactions t
WHERE    t.account_id = 1
ORDER BY t.value_date DESC,
         t.id         DESC
```

Using window functions

ID	VALUE_DATE	AMOUNT	BALANCE
9997	2014-03-18	-(99.17)	+19985.81
9981	2014-03-16	-(71.44)	19886.64
9979	2014-03-16	-(-94.60)	19815.20
9977	2014-03-16	-6.96	=19909.80
9971	2014-03-15	-65.95	19916.76

```
-------------------------------------------------------------------------------
| Id  | Operation                    | Name           | A-Rows |   A-Time   |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT             |                |     50 |00:00:00.01 |
|   1 |  WINDOW SORT                 |                |     50 |00:00:00.01 |
|   2 |   NESTED LOOPS               |                |   1101 |00:00:00.01 |
|   3 |    TABLE ACCESS BY INDEX ROWID| T_ACCOUNTS     |      1 |00:00:00.01 |
|*  4 |     INDEX UNIQUE SCAN        | SYS_C006991    |      1 |00:00:00.01 |
|   5 |    TABLE ACCESS BY INDEX ROWID| T_TRANSACTIONS |   1101 |00:00:00.01 |
|*  6 |     INDEX RANGE SCAN         | I_TRX_ACCO_ID  |   1101 |00:00:00.01 |
-------------------------------------------------------------------------------
```



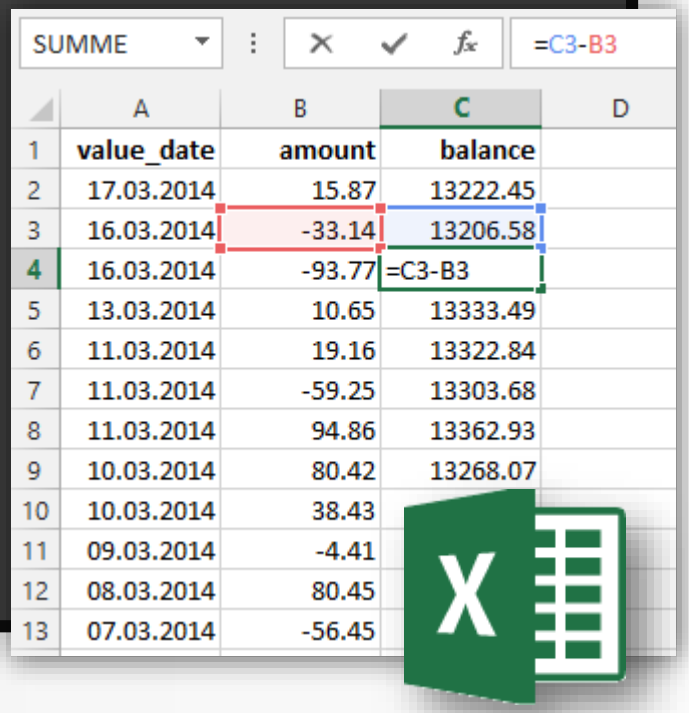
“Using the Oracle MODEL clause”


```
SELECT account_id, value_date, amount, balance
FROM (
  SELECT id, account_id, value_date, amount,
         current_balance AS balance
  FROM   v_transactions
) t
WHERE account_id = 1
MODEL
  PARTITION BY (account_id)
  DIMENSION BY (
    ROW_NUMBER() OVER (ORDER BY value_date DESC, id DESC) AS rn
  )
  MEASURES (value_date, amount, balance)
  RULES (
    balance[rn > 1] = balance[cv(rn) - 1] - amount[cv(rn) - 1]
  )
ORDER BY rn ASC
```

```
SELECT account_id, value_date, amount, balance
FROM (
  SELECT id, account_id, value_date, amount,
         current_balance AS balance
  FROM   v_transactions
) t
WHERE account_id = 1
MODEL
  PARTITION BY (account_id)
  DIMENSION BY (
    ROW_NUMBER() OVER (ORDER BY value_date DESC, id DESC) AS rn
  )
  MEASURES (value_date, amount, balance)
  RULES (
    balance[rn > 1] = balance[cv(rn) - 1] - amount[cv(rn) - 1]
  )
ORDER BY rn ASC
```

```
RULES (
   balance[rn > 1] = balance[cv(rn) - 1]
                   - amount [cv(rn) - 1]
)


-- does it look familiar?
```



```
-------------------------------------------------------------------------------
| Id  | Operation                      | Name           | A-Rows |   A-Time   |
-------------------------------------------------------------------------------
|   0 | SELECT STATEMENT               |                |     50 |00:00:00.02 |
|   1 |  SORT ORDER BY                 |                |     50 |00:00:00.02 |
|   2 |   SQL MODEL ORDERED            |                |   1101 |00:00:00.02 |
|   3 |    WINDOW SORT                 |                |   1101 |00:00:00.01 |
|   4 |     NESTED LOOPS               |                |   1101 |00:00:00.01 |
|   5 |      TABLE ACCESS BY INDEX ROWID| T_ACCOUNTS     |      1 |00:00:00.01 |
|*  6 |       INDEX UNIQUE SCAN        | SYS_C006991    |      1 |00:00:00.01 |
|*  7 |      TABLE ACCESS FULL         | T_TRANSACTIONS |   1101 |00:00:00.01 |
-------------------------------------------------------------------------------
```

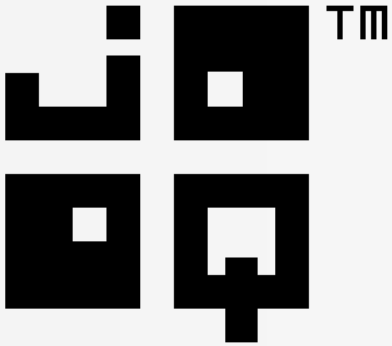
> The MODEL clause is Oracle's most powerful and underused feature

Our vision at Data Geekery - Revisited

- SQL dominates database systems
- SQL is expressive
- SQL is type safe

> “SQL is a device whose mystery is only exceeded by its power!”

Our vision at Data Geekery - Revisited



> “jOOQ is the best way to write SQL in Java”

```
SELECT
  t.*,
  t.current_balance - NVL(
    SUM(t.amount) OVER (
      PARTITION BY t.account_id
      ORDER BY     t.value_date DESC,
                   t.id         DESC
      ROWS BETWEEN UNBOUNDED PRECEDING
           AND     1         PRECEDING
    ),
  0) AS balance
FROM     v_transactions t
WHERE    t.account_id = 1
ORDER BY t.value_date DESC,
         t.id         DESC
```

```
DSL.using(connection)
   .select(t.VALUE_DATE,
           t.AMOUNT,
           t.CURRENT_BALANCE.sub(
             sum(t.AMOUNT).over(
                partitionBy(t.ACCOUNT_ID)
               .orderBy    (t.VALUE_DATE.desc(),
                            t.ID        .desc())
               .rowsBetweenUnboundedPreceding()
               .andPreceding(1)
             )
           ).nvl(0).as("balance"))
   .from   (V_TRANSACTIONS.as("t"))
   .where  (t.ACCOUNT_ID.eq(1))
   .orderBy(t.VALUE_DATE.desc(),
            t.ID        .desc())
```

Thank you

More free Java / SQL knowledge on:

- Blog: http://blog.jooq.org
- Twitter: @JavaOOQ