Explaining EXPLAIN

EXPLAIN

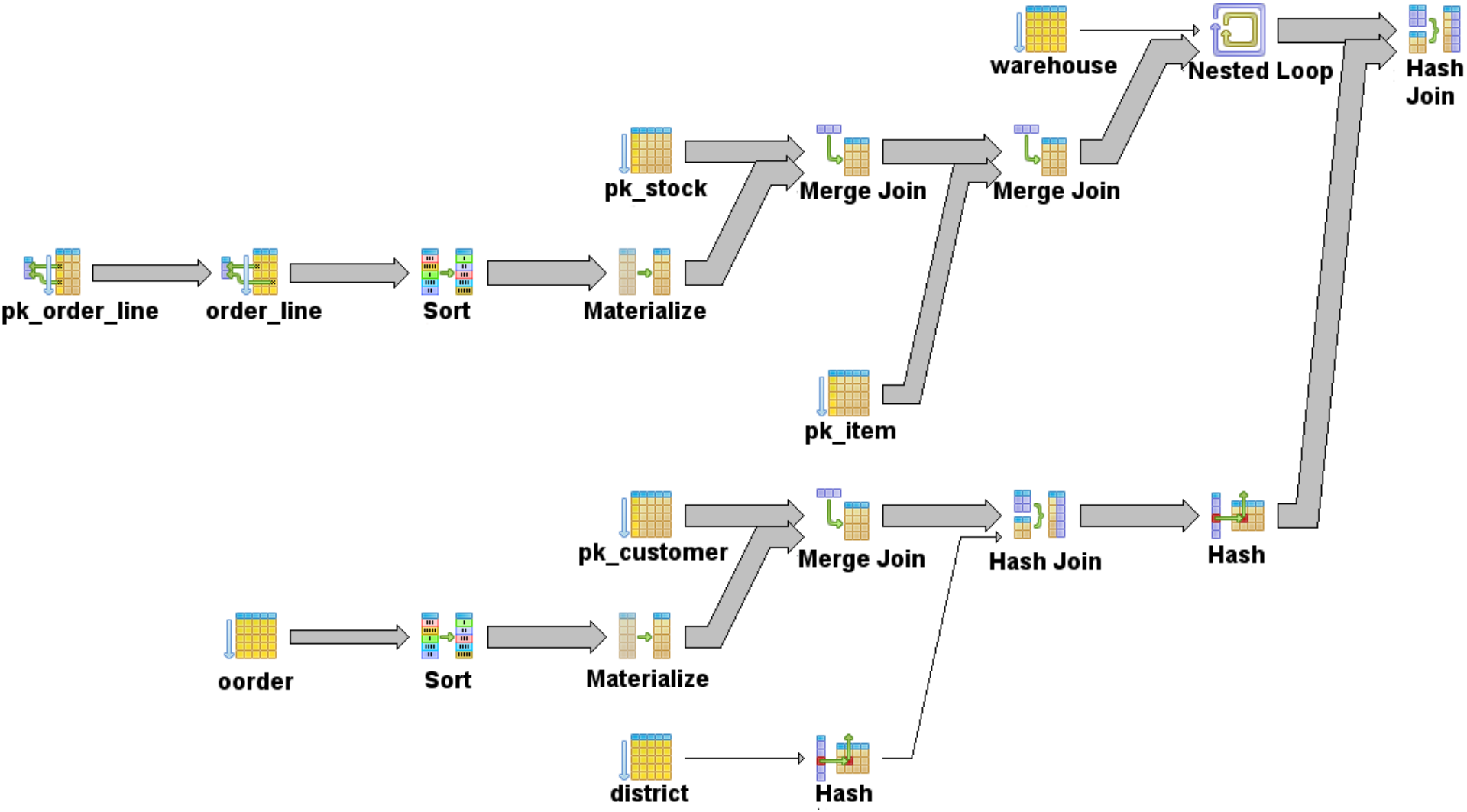
```
tpcc=> EXPLAIN
SELECT  *
  FROM oorder
  JOIN order_line ON (ol_w_id = o_w_id
                      AND ol_d_id = o_w_id
                      AND ol_o_id = o_id)
  JOIN item       ON (i_id = ol_i_id)
  JOIN stock      ON (s_w_id = o_w_id AND s_i_id = i_id)
  JOIN warehouse  ON (w_id = o_w_id)
  JOIN district   ON (d_w_id = w_id AND d_id = o_d_id)
  JOIN customer   ON (c_w_id = w_id
                      AND c_d_id = d_id
                      AND c_id = o_c_id)
 WHERE o_w_id = 1
```

- EXPLAIN works on any DML not just SELECT (ie UPDATE, DELETE, and INSERT)

EXPLAIN

```
Hash Join  (cost=22896.89..54208.53 rows=330801 width=1239)
  Hash Cond: (order_line.ol_o_id = oorder.o_id)
  ->  Nested Loop  (cost=8853.68..27149.42 rows=32734 width=542)
        ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
              Filter: (w_id = 1)
        ->  Merge Join  (cost=8853.68..26821.07 rows=32734 width=457)
              Merge Cond: (order_line.ol_i_id = item.i_id)
              ->  Merge Join  (cost=8852.66..22503.03 rows=32734 width=385)
                    Merge Cond: (stock.s_i_id = order_line.ol_i_id)
                    ->  Index Scan using pk_stock on stock  (cost=0.00..12910.70 rows=100000 width=315)
                          Index Cond: (s_w_id = 1)
                    ->  Materialize  (cost=8852.63..9261.81 rows=32734 width=70)
                          ->  Sort  (cost=8852.63..8934.47 rows=32734 width=70)
                                Sort Key: order_line.ol_i_id
                                ->  Bitmap Heap Scan on order_line  (cost=843.82..5053.83 rows=32734 width=70)
                                      Recheck Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
                                      ->  Bitmap Index Scan on pk_order_line  (cost=0.00..835.64 rows=32734 width=0)
                                            Index Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
              ->  Index Scan using pk_item on item  (cost=0.00..3659.26 rows=100000 width=72)
  ->  Hash  (cost=11040.12..11040.12 rows=29767 width=697)
        ->  Hash Join  (cost=3743.15..11040.12 rows=29767 width=697)
              Hash Cond: (oorder.o_d_id = district.d_id)
              ->  Merge Join  (cost=3741.90..10629.58 rows=29767 width=606)
                    Merge Cond: ((customer.c_d_id = oorder.o_d_id) AND (customer.c_id = oorder.o_c_id))
                    ->  Index Scan using pk_customer on customer  (cost=0.00..6215.00 rows=30000 width=564)
                          Index Cond: (c_w_id = 1)
                    ->  Materialize  (cost=3741.90..4116.90 rows=30000 width=42)
                          ->  Sort  (cost=3741.90..3816.90 rows=30000 width=42)
                                Sort Key: oorder.o_d_id, oorder.o_c_id
                                ->  Seq Scan on oorder  (cost=0.00..636.00 rows=30000 width=42)
                                      Filter: (o_w_id = 1)
              ->  Hash  (cost=1.12..1.12 rows=10 width=91)
                    ->  Seq Scan on district  (cost=0.00..1.12 rows=10 width=91)
                          Filter: (d_w_id = 1)
```

EXPLAIN in pgAdmin



Rows

```
Hash Join  (cost=22896.89..54208.53 rows=330801 width=1239)
  Hash Cond: (order_line.ol_o_id = oorder.o_id)
  ->  Nested Loop  (cost=8853.68..27149.42 rows=32734 width=542)
        ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
              Filter: (w_id = 1)
        ->  Merge Join  (cost=8853.68..26821.07 rows=32734 width=457)
              Merge Cond: (order_line.ol_i_id = item.i_id)
              ->  Merge Join  (cost=8852.66..22503.03 rows=32734 width=385)
                    Merge Cond: (stock.s_i_id = order_line.ol_i_id)
                    ->  Index Scan using pk_stock on stock  (cost=0.00..12910.70 rows=100000
                          Index Cond: (s_w_id = 1)
                    ->  Materialize  (cost=8852.63..9261.81 rows=32734 width=70)
                          ->  Sort  (cost=8852.63..8934.47 rows=32734 width=70)
                                Sort Key: order_line.ol_i_id
                                ->  Bitmap Heap Scan on order_line  (cost=843.82..5053.83 rows=327
                                      Recheck Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
                                      ->  Bitmap Index Scan on pk_order_line  (cost=0.00..835.64 rows=
                                            Index Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
              ->  Index Scan using pk_item on item  (cost=0.00..3659.26 rows=100000 width=
```

Cost

```
Hash Join  (cost=22896.89..54208.53 rows=330801 width=1239)
  Hash Cond: (order_line.ol_o_id = oorder.o_id)
  ->  Nested Loop  (cost=8853.68..27149.42 rows=32734 width=542)
        ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
              Filter: (w_id = 1)
        ->  Merge Join  (cost=8853.68..26821.07 rows=32734 width=457)
              Merge Cond: (order_line.ol_i_id = item.i_id)
              ->  Merge Join  (cost=8852.66..22503.03 rows=32734 width=385)
                    Merge Cond: (stock.s_i_id = order_line.ol_i_id)
                    ->  Index Scan using pk_stock on stock  (cost=0.00..12910.70 rows=100000
                          Index Cond: (s_w_id = 1)
                    ->  Materialize  (cost=8852.63..9261.81 rows=32734 width=70)
                          ->  Sort  (cost=8852.63..8934.47 rows=32734 width=70)
                                Sort Key: order_line.ol_i_id
                                ->  Bitmap Heap Scan on order_line  (cost=843.82..5053.83
                                      Recheck Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
                                      ->  Bitmap Index Scan on pk_order_line  (cost=0.00..835.64 rows=
                                            Index Cond: ((ol_w_id = 1) AND (ol_d_id = 1))
              ->  Index Scan using pk_item on item  (cost=0.00..3659.26 rows=100000 width=
```

Costs add up

Parameter	Description	Default	vs page read
seq_page_cost	cost of a sequentially fetched disk page.	1.00	
random_page_cost	cost of a nonsequentially fetched disk page.	4.00	4x slower
cpu_tuple_cost	cost of processing each tuple (row).	0.01	100x faster
cpu_operator_cost	cost of processing each operator or function call.	0.0025	400x faster
cpu_index_tuple_cost	cost of processing each index entry during an index scan.	0.005	1000x faster

- Costs are estimates of the time a node is expected to take
- By default costs are in units of “time a sequential 8kb block read takes”
- Each node has two costs, “startup” cost and “total” cost
- Costs cumulative – parents assume their children's costs
- Optimizer selects plans based on overall lowest startup and total cost

Explain Analyse

```
tpcc=> EXPLAIN ANALYSE
SELECT  *
  FROM oorder
  JOIN order_line   ON (ol_w_id = o_w_id
                        AND ol_d_id = o_w_id
                        AND ol_o_id = o_id)
  JOIN item         ON (i_id = ol_i_id)
  JOIN stock        ON (s_w_id = o_w_id AND s_i_id = i_id)
  JOIN warehouse    ON (w_id = o_w_id)
  JOIN district     ON (d_w_id = w_id AND d_id = o_d_id)
  JOIN customer     ON (c_w_id = w_id
                        AND c_d_id = d_id
                        AND c_id = o_c_id)
 WHERE o_w_id = 1 ;
```

Estimated Rows Versus Actual Rows

```
Hash Join  (cost=22896.89..54208.53 rows=330801 width=1239)
           (actual time=1232.035..5577.446 rows=299020 loops=1)
  Hash Cond: (order_line.ol_o_id = oorder.o_id)
  ->  Nested Loop  (cost=8853.68..27149.42 rows=32734 width=542)
                   (actual time=170.958..1545.218 rows=29902 loops=1)
      ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
                                 (actual time=0.019..0.023 rows=1 loops=1)
          Filter: (w_id = 1)
      ->  Merge Join  (cost=8853.68..26821.07 rows=32734 width=457)
                      (actual time=170.928..1424.466 rows=29902 loops=1)
          Merge Cond: (order_line.ol_i_id = item.i_id)
          ->  Merge Join  (cost=8852.66..22503.03 rows=32734 width=385)
                          (actual time=170.830..913.964 rows=29902 loops=1)
              Merge Cond: (stock.s_i_id = order_line.ol_i_id)

          ...
```

Large discrepancies between row estimates and reality are a prime suspect for poorly performing queries

Cost Versus Actual Time

```
Hash Join  (cost=22896.89..54208.53 rows=330801 width=1239)
           (actual time=1232.035..5577.446 rows=299020 loops=1)
  Hash Cond: (order_line.ol_o_id = oorder.o_id)
  ->  Nested Loop  (cost=8853.68..27149.42 rows=32734 width=542)
                   (actual time=170.958..1545.218 rows=29902 loops=1)
      ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
                                 (actual time=0.019..0.023 rows=1 loops=1)
          Filter: (w_id = 1)
      ->  Merge Join  (cost=8853.68..26821.07 rows=32734 width=457)
                      (actual time=170.928..1424.466 rows=29902 loops=1)
          Merge Cond: (order_line.ol_i_id = item.i_id)
          ->  Merge Join  (cost=8852.66..22503.03 rows=32734 width=385)
                          (actual time=170.830..913.964 rows=29902 loops=1)
              Merge Cond: (stock.s_i_id = order_line.ol_i_id)

          ...
```

- Costs are not (normally) in ms!
- But they should be roughly proportional to time

Plan Nodes

- Scans
  - Table scans (Sequential, Index, Bitmap, tid)
  - Other scans (Function, Values, Result)
- Joins
  - Nested Loop, Merge, Hash
- Set Operations, Partitioned Tables, and Inheritance
  - Append
  - SetOp Except, Intersect
- Miscellaneous
  - Sort, Aggregate, Unique, Limit
  - Materialize
  - SubPlan, Initplan

Table Scans – Sequential Scans

```
tpcc=> explain select * from stock;
                          QUERY PLAN
---------------------------------------------------------------
 Seq Scan on stock  (cost=0.00..5348.00 rows=100000 width=315)
```

- Fast to start up
- Sequential I/O is **much** faster than random access
- Only has to read each block once
- Produces unordered output

Table Scans – Index Scans

```
tpcc=> explain select * from stock where s_w_id = 1 and s_i_id = 1;
                                QUERY PLAN
-------------------------------------------------------------------------
 Index Scan using pk_stock on stock  (cost=0.00..8.28 rows=1 width=315)
   Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
```

- Random access is **much** slower than sequential I/O
- Also requires additional I/O to access index
- Worse, potentially has to read blocks multiple times
- Only scan which produces ordered output

Table Scans – Bitmap Index/Heap Scans

```
tpcc=# explain select * from stock where s_i_id in (1,3,5) or s_i_id in (2,4);
                                        QUERY PLAN
-------------------------------------------------------------------------------------------
 Bitmap Heap Scan on stock  (cost=5959.28..5978.85 rows=5 width=315)
   Recheck Cond: ((s_i_id = ANY ('{1,3,5}'::integer[])) OR (s_i_id = ANY ('{2,4}'::integer[])))
   ->  BitmapOr  (cost=5959.28..5959.28 rows=5 width=0)
         ->  Bitmap Index Scan on pk_stock  (cost=0.00..3354.76 rows=3 width=0)
               Index Cond: (s_i_id = ANY ('{1,3,5}'::integer[]))
         ->  Bitmap Index Scan on pk_stock  (cost=0.00..2604.51 rows=2 width=0)
               Index Cond: (s_i_id = ANY ('{2,4}'::integer[]))
```

- Best of both worlds – sequential I/O with index selectivity
- But slow to start up due to having to read all the index tuples and sort them
- Often selected for IN and =ANY(array) operators
- Can combine multiple indexes
- But optimizer can choose it for any indexable scan with low selectivity
- Often ideal for DSS queries
- Produces unordered output

More Scans (Function, Values, Result)

```
tpcc=> explain select * from generate_series(1,100);
                          QUERY PLAN
------------------------------------------------------------------------
 Function Scan on generate_series  (cost=0.00..12.50 rows=1000 width=4)
```

```
tpcc=> explain values (1), (2),(3);
                      QUERY PLAN
-------------------------------------------------------------
 Values Scan on "*VALUES*"  (cost=0.00..0.04 rows=3 width=4)
```

```
tpcc=> explain select 1;
            QUERY PLAN
---------------------------------------
 Result  (cost=0.00..0.01 rows=1 width=0)
```

Nested Loop Joins

```
tpcc=> explain select * from order_line join item on (i_id = ol_i_id) where ol_o_id = 1;
                                  QUERY PLAN
-------------------------------------------------------------------------------------------
 Nested Loop  (cost=0.00..7849.57 rows=102 width=142)
   ->  Index Scan using pk_o_line on order_line  (cost=0.00..7092.11 rows=102 width=70)
         Index Cond: (ol_o_id = 1)
   ->  Index Scan using pk_item on item  (cost=0.00..7.41 rows=1 width=72)
         Index Cond: (item.i_id = order_line.ol_i_id)
```

- Slowest form of join in theory
- But fast to produce first record
- In practice it's usually desirable for OLTP queries
- Performs very poorly if second child is slow
- Only join capable of executing CROSS JOIN
- Only join capable of inequality join conditions

Merge Joins

```
tpcc=> explain select * from order_line join item on (i_id = ol_i_id) ;
                                QUERY PLAN
-------------------------------------------------------------------------------------
 Merge Join  (cost=58862.12..67288.43 rows=301231 width=142)
   Merge Cond: (item.i_id = order_line.ol_i_id)
   ->  Index Scan using pk_item on item  (cost=0.00..3659.26 rows=100000 width=72)
   ->  Materialize  (cost=58861.10..62626.49 rows=301231 width=70)
         ->  Sort  (cost=58861.10..59614.18 rows=301231 width=70)
               Sort Key: order_line.ol_i_id
               ->  Seq Scan on order_line  (cost=0.00..6731.31 rows=301231 width=70)
```

- Can only be used for equality join conditions – and only for ordered data types
- Fastest join in theory, especially for large data sets
- Requires ordered inputs – which can require slow sorts or index scans
- Often ideal for data warehouse queries
- Startup can be slow, not desirable for OLTP queries

Hash Joins

```
tpcc=> explain select * from warehouse  join district on (d_w_id = w_id) ;
                          QUERY PLAN
------------------------------------------------------------------------
 Hash Join  (cost=1.02..2.26 rows=10 width=176)
   Hash Cond: (district.d_w_id = warehouse.w_id)
   ->  Seq Scan on district  (cost=0.00..1.10 rows=10 width=91)
   ->  Hash  (cost=1.01..1.01 rows=1 width=85)
         ->  Seq Scan on warehouse  (cost=0.00..1.01 rows=1 width=85)
```

- Can only be used for equality join conditions – and only for hashable data types
- Often ideal when joining a large table against a small table
- Slow to start due to hashing the second (usually smaller) table
- Can be especially slow if the estimate of the size of the tables is wrong

Set Operations – Inheritance and Partitioning

```
tpcc=> explain select * from s_partitions;
                                QUERY PLAN
-------------------------------------------------------------------------------------
 Result  (cost=0.00..5362.00 rows=100200 width=361)
   ->  Append  (cost=0.00..5362.00 rows=100200 width=361)
         ->  Seq Scan on stock_partitions  (cost=0.00..12.00 rows=200 width=361)
         ->  Seq Scan on stock_0 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_1 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_2 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_3 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_4 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_5 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_6 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_7 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_8 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
         ->  Seq Scan on stock_9 s_partitions  (cost=0.00..535.00 rows=10000 width=315)
```

- Produces unordered output which can reduce the available plans
- Adds overhead, especially if you have many partitions which can't be eliminated
- Also used for UNION ALL and UNION
  - Warning: UNION must eliminate duplicates which requires a sort!

Set Operations – Inheritance and Partitioning

```
tpcc=> explain select * from stock_partitions where s_w_id = 1 and s_i_id = 1;
                                  QUERY PLAN
-------------------------------------------------------------------------------------------------------
 Result  (cost=0.00..95.71 rows=11 width=361)
   ->  Append  (cost=0.00..95.71 rows=11 width=361)
         ->  Seq Scan on stock_partitions  (cost=0.00..13.00 rows=1 width=361)
               Filter: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_0 on stock_0 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_1 on stock_1 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_2 on stock_2 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_3 on stock_3 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_4 on stock_4 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_5 on stock_5 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_6 on stock_6 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_7 on stock_7 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_8 on stock_8 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_9 on stock_9 stock_partitions  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
```

Set Operations – Inheritance and Partitioning

```
tpcc=> set constraint_exclusion = on;
SET
tpcc=> explain select * from stock_partitions where s_w_id = 1 and s_i_id = 1;
                                    QUERY PLAN
-------------------------------------------------------------------------------------------------
 Result  (cost=0.00..21.27 rows=2 width=361)
   ->  Append  (cost=0.00..21.27 rows=2 width=361)
         ->  Seq Scan on stock_partitions  (cost=0.00..13.00 rows=1 width=361)
               Filter: ((s_w_id = 1) AND (s_i_id = 1))
         ->  Index Scan using pk_stock_0 on stock_0 stock_partitions
                                                  (cost=0.00..8.27 rows=1 width=315)
               Index Cond: ((s_w_id = 1) AND (s_i_id = 1))
```

- Make sure to set constraint_exclusion on if you have partition constraints set up

Sort

```
tpcc=> explain analyse select 1 from stock order by s_i_id;
------------------------------------------------------------------------------------------------
 Sort  (cost=13652.32..13902.31 rows=99995 width=4) (actual time=...)
   Sort Key: s_i_id
   Sort Method:  quicksort  Memory: 6345kB
   ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=4) (actual...)
 Total runtime: 744.391 ms
```

```
tpcc=> explain analyse select * from stock order by s_i_id;
------------------------------------------------------------------------------------------------
 Sort  (cost=42709.32..42959.31 rows=99995 width=315) (actual time=...)
   Sort Key: s_i_id
   Sort Method:  external sort  Disk: 32024kB
   ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=315) (actual...)
 Total runtime: 2550.343 ms
```

- Not just for ORDER BY – also DISTINCT, GROUP BY, UNION, and merge joins
- Sorts always have large startup times – bad for OLTP
- If sort fits in work_mem then it will use faster in-memory quicksort
- Otherwise it will use slower external disk sort using temporary files

Aggregates

```
tpcc=> explain select s_i_id, count(*) from stock group by s_i_id;
------------------------------------------------------------------------------------------
 GroupAggregate  (cost=13652.32..15652.22 rows=99995 width=4)
   ->  Sort  (cost=13652.32..13902.31 rows=99995 width=4)
         Sort Key: s_i_id
         ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=4)
```

```
tpcc=> explain select s_i_id, count(*) from stock group by s_i_id;
------------------------------------------------------------------------------------------
 HashAggregate  (cost=5847.93..7097.86 rows=99995 width=4)
   ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=4)
```

```
tpcc=> explain select distinct s_i_id from stock;
------------------------------------------------------------------------
 Unique  (cost=13652.32..14152.29 rows=99995 width=4)
   ->  Sort  (cost=13652.32..13902.31 rows=99995 width=4)
         Sort Key: s_i_id
         ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=4)
```

LIMIT

```
tpcc=> explain analyse select * from stock limit 10 offset 10;
                                                    QUERY PLAN
-------------------------------------------------------------------------------------------------------------------
 Limit  (cost=0.53..1.07 rows=10 width=315) (actual time=0.061..0.113 rows=...)
   ->  Seq Scan on stock  (cost=0.00..5347.95 rows=99995 width=315)
                                 (actual time=0.018..0.054 rows=20 loops=1)
```

- Limit handles both LIMIT and OFFSET
- Limit can also be used for min() and max() if there's no where clause
- Records skipped for OFFSET must still be generated and then thrown out!

- Note that the cost of child scan is still the full cost
- However the actual time spent reflects the time saved due to the limit

- Sort combined with Limit can use an optimized form of sort

Subplans for Subqueries

```
tpcc=# explain select (select count(*) from item where i_id = empty.i_id) from empty;
                              QUERY PLAN
-----------------------------------------------------------------------------
 Seq Scan on empty  (cost=0.00..19933.22 rows=2400 width=4)
   SubPlan
     ->  Aggregate  (cost=8.28..8.29 rows=1 width=0)
           ->  Index Scan using pk_item on item  (cost=0.00..8.28 rows=1 width=0)
                 Index Cond: (i_id = $0)
```

```
tpcc=# explain  select (select count(*) from item) from empty;
                            QUERY PLAN
-------------------------------------------------------------------------
 Seq Scan on empty  (cost=2522.01..2556.01 rows=2400 width=0)
   InitPlan
     ->  Aggregate  (cost=2522.00..2522.01 rows=1 width=0)
           ->  Seq Scan on item  (cost=0.00..2272.00 rows=100000 width=0)
```

“never executed” ???

```
tpcc=> explain analyze select * from empty join item using (i_id);
                                    QUERY PLAN
-------------------------------------------------------------------------------------------------------
 Hash Join  (cost=4694.00..5957.00 rows=2400 width=72)
            (actual time=0.008..0.008 rows=0 loops=1)
   Hash Cond: (empty.i_id = item.i_id)
   ->  Seq Scan on empty  (cost=0.00..34.00 rows=2400 width=4)
                          (actual time=0.003..0.003 rows=0 loops=1)
   ->  Hash  (cost=2272.00..2272.00 rows=100000 width=72) (never executed)
         ->  Seq Scan on item  (cost=0.00..2272.00 rows=100000 width=72) (never executed)
 Total runtime: 0.136 ms
```

- Postgres only generates the hash if it's needed to match any records
- Also often happens in Nested Loop joins, Merge Joins
- Can also happen for subqueries used in select target lists

Real World Problems

- Estimates are inaccurate
  - Have you analysed recently?
  - Are your tables empty? Postgres falls back to a heuristic.
  - Are your columns strongly correlated?
  - Are your clauses written like
    WHERE i+0 = val or lower(t) = 'foo' ?
- Not using an available index
  - Are you sure using the index would actually be helpful?
  - Are you using LIKE? Is your index using text_pattern_ops?
- Mysterious time sinks
  - Triggers? Do you have indexes on foreign keys?
  - Dead tuples? Have you vacuumed recently?

Asking for Help

- State your PostgreSQL version
- Make sure you have vacuumed and analysed appropriately
- Always include EXPLAIN ANALYSE output
- Include queries/tables/data when possible

pgsql-performance@postgresql.org

Thanks
Robert Treat, Greg Sabino Mullane, AndrewSN@#postgresql, Magnifikus@#postgresql, Bryan Encina, Neil Conway