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Informe sobre Optimización de Consultas: FBV

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Introducción

Una Base de datos comienza con un problema en el cual se quieren almacenar datos de forma persistente. De este problema y su universo que se suele llamar «minimundo» surge un modelo lógico que, después de varias iteraciones, representa de la forma mas exacta posible el problema (o al menos lo relacionado con almacenamiento de datos).

Luego del modelado, el siguiente paso es llevar ese modelo lógico a uno mas concreto. En este paso se crean entonces todas las tablas y relaciones entre las mismas, se declaran las resticciónes y se determinan los disparadores que tendrá la base de datos.

Cuando termina toda la fase transformación del modelo lógico a físico (o de más bajo nivel), se podría decir que la Base de datos esta lista para recibir datos. Mientras el volumen de datos sea pequeño, el manejador encargado de realizar las consultas, actualizaciones o transacciones puede manejar con relativa facilidad los datos. Sin embargo, las bases de datos tienen a crecer más que a quedarse estáticas y, cuando esto ocurre, algunas operaciones pueden tornarse costosas.

Afortunadamente, los sistemas manejadores de bases de datos proveen estructuras y facilidades para optimizar estas operaciones.Se tienen, entre las más famosas para optimizar consultas, indices, tablas particionadas o ajuste de parámetros como memoria. Estas estructuras, no obstante, deben ser especificadas por el usuario encargado del buen funcionamiento de la base de datos.

Las estadísticas de cada tabla juegan un papel importante en la elección de un mejor plan de ejecución por parte del manejador de la base de datos y para la elección de una estructura auxiliar. Las estadísticas tambíen le dicen mucho al administrador de la base de datos acerca de qué estructura se debe crear para optimizar un grupo de consultas u operaciones sobre la base de datos.

El presente informe tiene como finalidad describir el comportamiento de estructuras de optimización de consultas ante una Báse de datos de un tamaño considerablemente grande sobre la cuál se deben optimizar ciertas consultas. Para optimizar estas consultas, el úso de los conocimientos teóricos acerca de optimización de consultas, las estadísticas que se puedan obtener del manejador, las que se puedan derivar de estas y serán las herramientas para determinar que estructuras se deberían usar o no en alguna de las consultas planteadas.

Estadísticas sobre la base de datos FBV

El primer paso pasa poder optimizar las consultas dadas es conocer el volumen total de la base de datos, el volumen de cada tabla individual, el tamaño promedio de cada fila, y las estadísticas apropiadas para cada consulta.

Estadísticas generales de la base de datos

En esta subsección se describen las estadísticas relacionadas con la base de datos en su totalidad, independientemente de las consultas que se vayan a optimizar.

Volumen total de los datos

Para determinar el volumen total de tuplas existentes en la base de datos se realizó la siguiente consulta:

```sql
select sum(n_live_tup)
from pg_stat_user_tables
where schemaname='original';
```

La consulta arrojó un valor de 8660591 tuplas.

Volumen total de cada tabla

Para calcular el volumen total de cada tabla utilizamos la siguiente consulta:

```sql
select
  c.relname,
  n_live_tup,
  relpages,
  floor(n_live_tup/relpages::float) as tuples_per_page
from
  pg_stat_user_tables b,
  pg_class c
where relnamespace = (select oid from pg_namespace where nspname='original')
  and schemaname = 'original'
  and b.relname= c.relname;
```

De esta consulta se obtuvieron los resultados de +@tab:general .

Tabla 1: Tuplas, páginas y tuplas por página de las tablas de FBV.

Tabla	Tuplas	Páginas	Tuplas por pagina
part	200000	3715	53
supplier	10000	213	46
partusupp	800000	17451	45
lineitem	6001181	98544	60
region	5	1	5
nation	25	1	25
customer	150000	3566	42
orders	1500000	25196	59
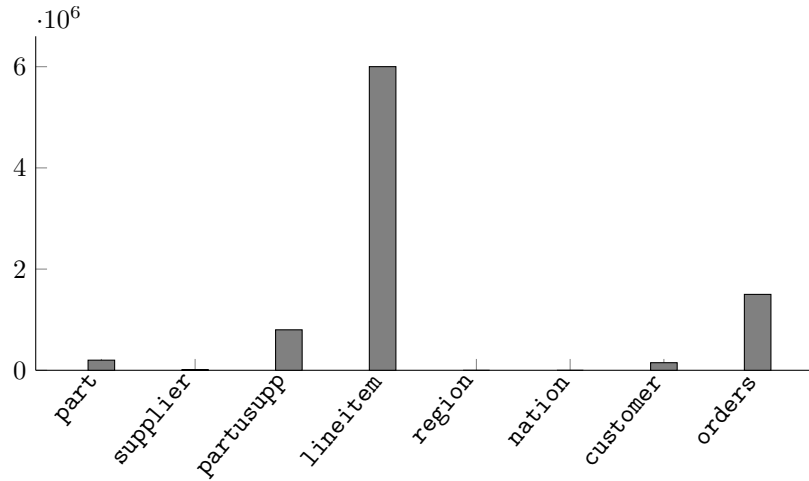
Figura 1: Cantidad de tuplas en cada tabla

En la Figura 1 podemos observar que la tabla de `lineitem` ocupa la mayor parte de los datos almacenados (aproximadamente un 69 % del total de tuplas). Cualquier consulta que requiera acceder a una buena parte de los datos almacenados en esta tabla exigirá mucha atención al momento de ser optimizada.

Para las tablas `nation` y `region`, dado que caben en una sola página, se puede concluir que no necesitan optimización alguna pues un acceso directo es siempre la mejor opción para recuperar sus registros.

Análisis de cada tabla

En el análisis de cada tabla tomarán en cuenta los siguientes aspectos:

- Tamaño promedio de la tupla

- Para cada atributo, su tamaño promedio, cantidad de elementos distintos y factor de reducción.

- Cualquier otra estadística que resulte últil para la optimización de alguna de las consultas propuestas.

Para el cálculo del tamaño promedio de cada tupla, en todas las tablas, se realizó la siguiente consulta:

```sql
select
  tablename,
  sum(avg_width) as tam_promedio_tuplas
from
  pg_stats
where
  tablename in (
    select
      relname
    from pg_stat_user_tables)
group by
  tablename;
```

De la cual se obtuvieron los siguientes resultados

Tabla 2: Tamaño promedio de cada tupla

Tabla	Tamaño promedio de tupla
part	114
supplier	137
partusupp	144
lineitem	98
region	78
nation	91
customer	158
orders	100

En el análisis de cada tabla, se realizó una consulta diseñada para extraer la siguiente información acerca de las tablas:

- El tamaño medio de cada atributo

- El número de valores distintos que tiene la columna. Si el valor es -1, es un valor único

- La correlación que existe entre el orden lógico y el orden físico (mientras más cercano a 1 o -1 mejor a la hora de que el manejador haga index scan)

- La frecuencia más alta hallada. Esta nos permite tener una cota superior para un determinado valor

- El factor reductor. Para conocer la selectividad de la columna.

La consulta es la siguiente:

```
prepare stats_table as
select
  attname,
  avg_width,
  ( case
      when n_distinct < 0  and n_distinct <> -1
        then -n_distinct * t.reltuples
        else n_distinct
      end) as ndistinct,
  correlation,
  most_common_freqs[1] as upper_bound,
  ( case
      when n_distinct < 0
        then -1 / (n_distinct * t.reltuples)
        else 1 / n_distinct
      end) as FR
from
  pg_stats,
  ( select
      relname,
      reltuples
    from
      pg_class
    where relnamespace = (
      select
        oid
      from
        pg_namespace
      where
        nspname='original')
    ) t
where t.relname = tablename
  and tablename = $1
  and schemaname = 'original'
order by
  fr;
```

Análisis de `lineitem`

Al ejecutar la consulta sobre lineitem se obtuvieron los resultados mostrados en la Tabla 3. De la tabla se puede decir que las columnas con peor selectividad son `l_linestatus`, `l_returnflag` y `l_shipsintruct`. Por otro lado, los atributos con mayor selectividad tenemos `l_comment`, `l_orderkey` y `l_extendedprice`.

Tabla 3: Estadísticas para la relación `lineitem`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
l_orderkey	4	1206300	1	0.000016667	0.000000829
l_partkey	4	197029	0.00235099	0.00003	5.07539e-06
l_suppkey	4	10000	-0.000106049	0.000173333	0.0001
l_linenumber	4	7	0.176068	0.250317	0.14285714
l_quantity	5	50	0.0195651	0.0205067	0.02
l_extendedprice	8	767024	0.000341259	2.33333e-05	1.3037401e-06
l_discount	4	11	0.0868008	0.0922367	0.09090909
l_tax	4	9	0.109181	0.11199	0.11111111
l_returnflag	2	3	0.377041	0.506517	0.33333333
l_linestatus	2	2	0.499747	0.500087	0.5
l_shipdate	4	2525	-0.00126623	0.000536667	0.00039603
l_comitdate	4	2465	-0.00119272	0.000536667	0.00040567
l_receipdate	4	2543	-0.00128363	0.000553333	0.00039323
l_shipinstruct	13	4	0.250591	0.250767	0.25
l_shipmode	5	7	0.145059	0.143523	0.14285714
l_comment	27	1763690	0.000151724	0.000193333	0.000000567

Análisis de `orders`

Al ejecutar la consulta sobre orders, se obtuvieron los resultados mostrados en la Tabla 4.

Tabla 4: Estadísticas para la relación `orders`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
o_orderkey	4	-1	0.999999	-	6.666666667e-07
o_comment	49	1461050	0.000667332	1.33333e-05	6.844383362e-07
o_totalprice	8	1439660	0.00179892	0.00001	6.946098966e-07
o_custkey	4	96824	0.00212814	4.66667e-05	0.000010328
o_orderdate	4	2406	0.00254059	0.00056	0.0004156276
o_clerk	16	1000	0.000855419	0.00118	0.001
o_orderpriority	9	5	0.201246	0.201113	0.2
o_orderstatus	2	3	0.476312	0.488067	0.3333333333
o_shippriority	4	1	1	1	1

Análisis de `customer`

Al ejecutar la consulta sobre orders, se obtuvieron los resultados mostrados en la Tabla 5.

Tabla 5: Estadísticas para la relación `customer`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
c_phone	16	-1	0.000497003		6.666666667e-06
c_custkey	4	-1	0.999988		6.666666667e-06
c_name	19	-1	0.999988		6.666666667e-06
c_address	26	-1	0.0011718		6.666666667e-06
c_comment	73	149968	-0.000241386	1.33333e-05	6.668089192e-06
c_acctbal	6	140187	0.00410825	2.66667e-05	7.133329053e-06
c_nationkey	4	25	0.0405429	0.0410733	0.04
c_mktsegment	9	5	0.200573	0.20126	0.2

Análisis de `part`

Al ejecutar la consulta sobre part, se obtuvieron los resultados mostrados en la Tabla 6.

Tabla 6: Estadísticas para la relación `part`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
p_partkey	4	-1	0.999905		5e-06
p_name	33	199997	-0.000591865	1e-05	5.000075001e-06
p_comment	14	131753	-0.00166307	0.000615	7.589960000e-06
p_retailprice	6	20899	0.192004		4.784917938e-05
p_type	21	150	0.0095101	0.007255	0.0066666666667
p_size	4	50	0.0237148	0.020885	0.02
p_container	8	40	0.0252164	0.025765	0.025
p_brand	9	25	0.0414318	0.041165	0.04
p_mfgr	15	5	0.201261	0.20152	0.2

Análisis de `partsupplier`

Al ejecutar la consulta sobre partsupplier, se obtuvieron los resultados mostrados en la Tabla 7.

Tabla 7: Estadísticas para la relación `partsupplier`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
ps_comment	126	798569	0.000561844	6.66667e-06	1.252239944e-06
ps_partkey	4	200105	0.999993	1.33333e-05	4.997376377e-06

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
ps_supplycost	6	97978	-0.000937153	4e-05	1.020637285e-05
ps_suppkey	4	10000	0.00181275	0.000156667	0.0001
ps_availqty	4	9999	0.00135311	0.00018	0.0001000100010

Análisis de `supplier`

Al ejecutar la consulta sobre supplier, se obtuvieron los resultados mostrados en la Tabla 8.

Tabla 8: Estadísticas para la relación `supplier`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
s_address	25	-1	0.000978475		0.0001
s_suppkey	4	-1	0.999954		0.0001
s_name	19	-1	0.999954		0.0001
s_phone	16	-1	0.00634556		0.0001
s_comment	63	-1	-0.00867227		0.0001
s_acctbal	6	9955	0.0158685	0.0002	0.0001004
s_nationkey	4	25	0.0458266	0.0438	0.04

Análisis de `nation`

Al ejecutar la consulta sobre nation, se obtuvieron los resultados mostrados en la Tabla 9.

Tabla 9: Estadísticas para la relación `nation`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
n_comment	75	-1	0.0469231		0.04
n_nationkey	4	-1	1		0.04
n_name	8	-1	0.913077		0.04
n_regionkey	4	5	0.347692	0.2	0.2

Análisis de `region`

Al ejecutar la consulta sobre region, se obtuvieron los resultados mostrados en la Tabla 10.

Tabla 10: Estadísticas para la relación `region`.

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
r_regionkey	4	-1	1		0.2

Atributo	Tam. pr.	# vals. dist.	Correlación	Cota sup.	Selectividad
r_name	7	-1	1		0.2
r_comment	67	-1	0.6		0.2

Optimización de las consultas

Consulta Q11: Proveedor con el mínimo costo

La consulta a optimizar es la siguiente:

```
select
  s_acctbal,
  s_name,
  n_name,
  p_partkey,
  p_mfgr,
  s_address,
  s_phone,
  s_comment
from
  part,
  supplier,
  partsupp,
  nation,
  region
where
  p_partkey = ps_partkey
  and s_suppkey = ps_suppkey
  and p_size = $1
  and p_type like $2
  and s_nationkey = n_nationkey
  and n_regionkey = r_regionkey
  and r_name = $3
  and ps_supplycost = (
    select
      min(ps_supplycost)
    from
      partsupp,
      supplier,
      nation,
      region
    where
```

```
      p_partkey = ps_partkey
      and s_suppkey = ps_suppkey
      and s_nationkey = n_nationkey
      and n_regionkey = r_regionkey
      and r_name = $3
  )
order by
  s_acctbal desc,
  n_name,
  s_name,
  p_partkey;
```

Al hacer `Explain Analyze` sobre la consulta sin ningúna estructura adicional se obtuvo
el plan de ejecución mostrado en la Figura 2, con una duración total de 1992 ms. Puede
verse que el nodo más caro y lento en este grafo fue el *Seq Scan* (906 ms) que se hace sobre
`partsupp` como parte del *Hash Join* con la tabla `supplier` sobre la igualdad de los atributos
`ps_suppkey` y `s_suppkey`, cuyos nombres indican que se trata de un join sobre una clave
foránea entre la entidad `partsupp` y su `supplier` correspondiente.

Figura 2: Árbol de ejecucion de la consulta Q11 original

Cabe mencionar que antes de plantear cualquier cambio a la estructura de una base de datos
para mejorar el desempeño de una consulta, es buena idea revisar la consulta en sí. En este
caso, puede notarse que la consulta tiene una sub-consulta correlacionada, en la cual se busca
el costo mínimo para una pieza entre todos los proveedores que la ofrecen. Esta sub-consulta
puede entonces reescribirse con una *Common Table Expression* con la palabra clave `with` para
evitar que se evalúe más de una vez por cada pieza. Resulta entonces la siguiente consulta
con idéntica semántica:

```
with minPerPart as (
  select
    min(ps_supplycost) as mpp_mincost,
    ps_partkey         as mpp_partkey
```

```
    from
      part,
      partsupp,
      supplier,
      nation,
      region
    where p_partkey          = ps_partkey
      and ps_suppkey         = s_suppkey
      and s_nationkey        = n_nationkey
      and n_regionkey        = r_regionkey
      and p_size             = $1
      and reverse(p_type) like reverse($2)
      and r_name             = $3
    group by
      mpp_partkey
    order by
      mpp_partkey
)
select
  s_acctbal,
  s_name,
  n_name,
  p_partkey,
  p_mfgr,
  s_address,
  s_phone,
  s_comment
from
  part,
  supplier,
  partsupp,
  nation,
  region,
  minPerPart
where p_partkey          = ps_partkey
  and ps_suppkey         = s_suppkey
  and s_nationkey        = n_nationkey
  and p_size             = $1
  and reverse(p_type) like reverse($2)
  and r_name             = $3
  and ps_supplycost      = mpp_mincost
  and p_partkey          = mpp_partkey
order by
  s_acctbal desc,
  n_name,
```

```
    s_name,
    p_partkey;
```

Luego de reescribir la consulta, agregamos un par de índices a la base de datos. El primero lo creamos sobre la tabla `part`, en las columnas `p_size` y el reverso de `p_type`, en ese órden. Éste índice le permite al manejador conseguir primero las piezas de un tamaño específico, y luego las que tengan un sufijo en particular. Como nos interesa que la comparación sea por sufijo en lugar de por prefijo, sólo tiene sentido usar el reverso de `p_type`, invirtiendo también ambos operandos del operador `like`. Los atributos del índice están en este órden porque invertirlos no permitiría hacer búsquedas por igualdad en el atributo `p_size`, que es lo que se desea en esta consulta. Este índice fue creado con el siguiente comando:

```
create index idx_q11_p_size_reverse_type
  on part (p_size, reverse(p_type) text_pattern_ops);
```

El segundo índice que agregamos para esta consulta es sobre la tabla `partsupp`, en los atributos `ps_partkey`, `ps_suppkey`, `ps_supplycost`, y permite que dos operaciones *Join* utilicen *Index Only Scan*s en el lado interno, en lugar de la costosa secuencia *Bitmap Index Scan - Bitmap Heap Scan* sobre una tabla del tamaño de `partsupp`. Este índice fue creado con el siguiente comando:

```
create index idx_q11_partsupp
  on partsupp (ps_partkey, ps_suppkey, ps_supplycost);
```

Luego de la reescritura de la consulta y la creación del par de índices, el tiempo de ejecución (con caché fría) de esta consulta baja de 1992 ms a 334 ms, tan sólo el 16.7 % del tiempo de la consulta original. El plan resultante es el mostrado en la Figura 3.
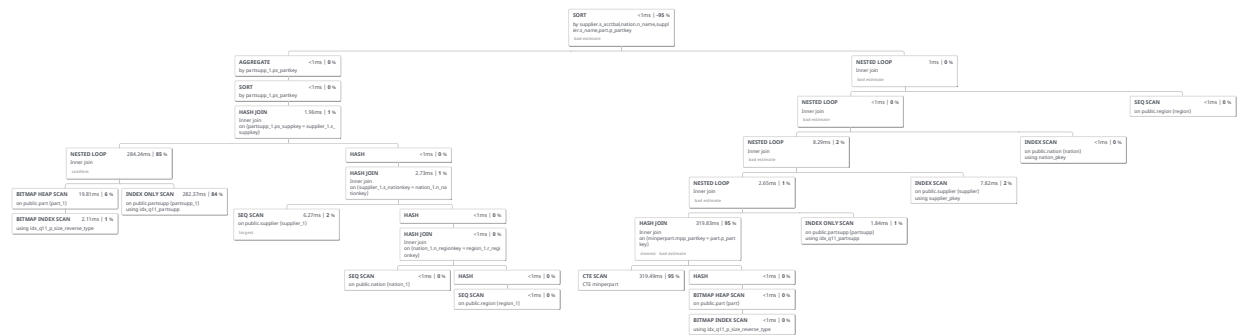

Figura 3: Árbol de ejecucion de la consulta Q11 modificada, con índices

Luego de esta mejora, consideramos cambiar el índice sobre la tabla `part` para que incluyera más columnas, específicamente `p_partkey` y `part.p_mfgr`, ya que estas columnas son usadas en nodos subsecuentes, de forma que los pares de nodos *Bitmap Index Scan - Bitmap Heap Scan* sobre la tabla `part` se pudieran convertir en un *Index Only Scan*. Sin embargo, este no

es el caso, debido a que el índice resultante es demasiado grande, y el factor reductor del nodo muy pequeño como para esto, y termina siendo más económico el par de nodos *Bitmap Index Scan - Bitmap Heap Scan* sobre el índice sencillo.

Otra crítica posible a esta propuesta está en el nuevo nodo `CTE Scan`. Este nodo resulta de la evaluación de la consulta `with` dentro de la consulta principal, y su tiempo de ejecución es significativo, unos 319 ms. Sin embargo, esta alternativa resulta muy superior a la original, en la cual se evaluaba muchas veces la misma consulta correlacionada, generando un árbol más costoso.

Consulta Q12: Prioridad de envío

Consulta Q13: Reporte de ítems devueltos

La consulta que se tuvo que optimizar fue la siguiente:

```
prepare q13 as
select c_custkey,c_name, sum(l_extendedprice * (1 - l_discount)) as revenue,
    c_acctbal, n_name, c_address, c_phone, c_comment
from customer, orders, lineitem, nation
where c_custkey = o_custkey and l_orderkey = o_orderkey
    and o_orderdate >= $1 and o_orderdate < $1 + interval '3 month'
    and l_returnflag = 'r' and c_nationkey = n_nationkey
group by c_custkey, c_name, c_acctbal, c_phone, n_name, c_address, c_comment
order by revenue desc;
```

Todas las pruebas para esta consulta se realizaron con una isntancia dedicada de AWS (Amazon Web Services).

Al ejecutar la consulta sin ningúna estructura adicional se obtuvo el plan de ejecución mostrado en la la Figura 4 . En ella se puede observar que la operación de *scan* sobre la tabla `lineitem` es la operación mas costosa, lenta y extensa de toda la consulta.

En la Figura se puede observar que en todas las tablas involucradas se ejecuta un *Sequential scan* , siendo la tabla `lineitem` la tabla que consume la mayor parte del tiempo de la consulta. Luego, se hacen las proyecciones sobre las tablas `customer`, `nation` y `orders` para obtener los atributos deseados de cada tabla. Esto no sucede en `lineitem`.

Los siguientes pasos son un *Hash Join* entre las tuplas recuperadas de `lineitem` y `orders`, seguido de otro *Hash Join* entre el resultado previo y la relación `customer` y finalmente un último *Hash Join* sobre el resultado de las dos operaciones previas y la tabla `nation`.

Ya para finalizar se procede a ordenar todas las túplas por los atributos especificados en la cláusula **group by** , se ejecuta la función de agregación `sum(l_extendedprice * (1 - l_discount))` y se ordena de forma descendiente la tabla resultante de acuerdo al resultado de la función de agregación.
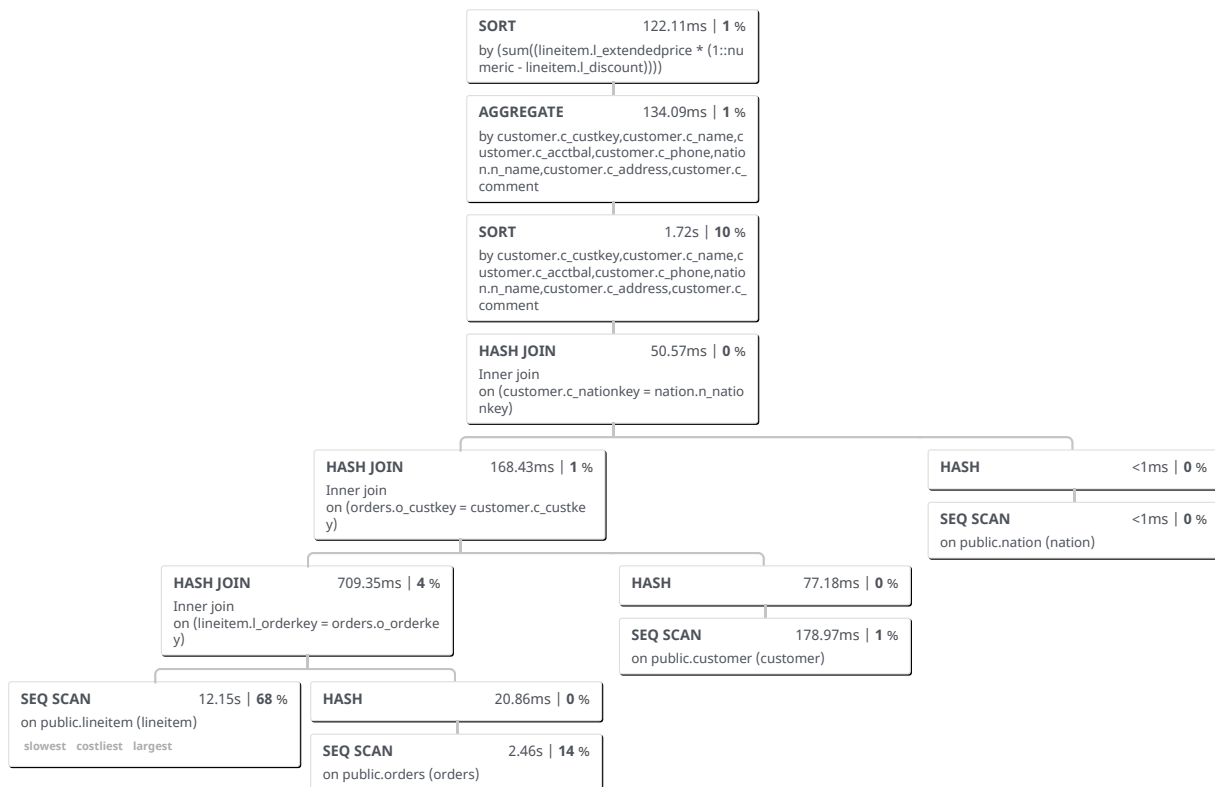
Figura 4: Arbol de ejecucion de la consulta Q13

El tiempo total de ejecución de la consulta fue de 17826,476 ms de los cuales, 12154,645 ms tomó la recuperación de las tuplas deseadas de la tabla 'lineitem'. Desde el sistema operativo, la operación tardó 17940.00 ms , 100 ms extra por el *overhead* de iniciar el proceso psql.

Optimizar la recuperación de datos para la tabla `lineitem` fue el objetivo principal para una mejora notable de esta consulta.

Primera Iteración

Para evitar un escaneo secuencial sobre toda la tabla `lineitem` se propuso crear un índice compuesto sobre los atributos `l_returnflag`, `l_orderkey`, `l_extendedprice` y `l_discount` y el mismo orden en el que aqui se menciona.

Un índice con todos estos atributos tendría tuplas de 18 bytes de clave mas los gastos 'administrativos' del apuntador a la página donde se encuentra la tupla completa. Este índice reduciría el número de operaciones de entrada-salida de 98544 con el escaneo secuencial en `lineitem` a un total estimado de 29563 páginas.

Por otro lado el índice tendría las entradas ordenadas de tal manera que se podría evitar un escaneo completo sobre el índice al solo tener que buscar las entradas que cumplan la condición: `l_returnflag`='R'. Para conocer cual es el porcentaje de la tabla `lineitem` que cumple esta condición se realizó la siguiente consulta sobre las estadísticas:

```sql
select most_common_vals, most_common_freqs
    from pg_stats
    where attname='l_returnflag';
```

Esta consulta devolvió lo siguiente:

Tabla 11: La tabla muestra que para el valor R, solo un 25 % de las tuplas lo cumplen.

most_common_vals	most_common_freqs
{N,R,A}	{0.5083,0.251133,0.240567}

Dado que el factor de reducción de la columna es 0.33333333... se tiene un mejor pronóstico para el índice al solo tener que recuperar aproximadamente $29563 \times 0.25 = 7390$ páginas.

El mísmo razonamiento se aplicó para la tabla `orders` que, si bien no es tan masiva como la anterior, optimizar el acceso a la misma puede mejorar el desempeño de la consulta.

Para orders se propuso un índice sobre los atributos `o_orderdate`, `o_orderkey` y `o_custkey` en ese orden. Este índice reduciría el número de operaciones de entrada- salida para el escaneo de orders de 25196 a un estimado de 5124 páginas.

Como el factor reductor de este atributo es bajo, 0.00041 para ser exactos, y la cota superior

es 0.00056 se estimó obtener un total de $90 \times 0.00056 \times 100 = 5{,}04\,\%$ de las tuplas (259 páginas) del índice en el peor caso y de $90 \times 0.00041 \times 100 = 3{,}69\,\%$.

Luego de la de este análisis se procedió a crear los índices:

```sql
--elementos para la fecha
create index q13_orders_idx
    on orders(o_orderdate, o_orderkey, o_custkey);

--elementos para lineitem
create index q13_lineitem_idx
    on lineitem(l_returnflag, l_orderkey,
        l_extendedprice, l_discount);
```

Luego se consultó el número de páginas que tenía cada índice con la consulta:

```sql
select relname,relpages
    from pg_class
    where relname in ('q13_orders_idx','q13_lineitem_idx');
```

obteniendose la Tabla 12 .

Tabla 12: Cantidad de páginas de los índices propuestos

Índice	Paginas
q13_lineitem_idx	29755
q13_orders_idx	5779

Finalmente se procedio a ejecutar la consulta Q13 mejorada para observar que ocurría. El arbol de ejecución con la duración de cada nodo se puede observar en la la Figura 5.

En la Figura 5 se puede observar un cambio en el plan de ejecución de la cosulta con respecto a la original: Ahora se realiza un *Index only scan* sobre los índices definidos sobre tablas `lineitem` y `orders` reduciendo en el caso de `lineitem`, de 12154,645 ms, a 480,31 ms la recuperación de los atributos deseados de esta tabla. Esta reducción representa un $96{,}04\,\%$ de mejoría con respecto al nodo del plan original.

Para la relación `customer` se realiza un *Index scan* y sobre `nation` se realiza un *Sequential scan* seguido de una proyección basada en hash para recuperar los atributos deseados de la tabla.

Luego comienza la fase de operaciones join. Primero se realiza un *Merge Join* sobre las tuplas recuperadas del *Index only scan* sobre los índices de `lineitem` y `orders`, seguido de un ordenamiento del resultado para luego realizar un segundo *Merge Join* entre el resultado previo y las tuplas de `customer`. Finalmente, se realiza un *Hash Join* sobre el resultado previo

y la relación `nation`.

Luejo de realizarse los Joins se procede a ordenar la tabla resultane de acuerdo a los atributos mencionados en la cláusula **group by**, siendo esta la operación más lenta ahora; se realiza el calculo de la función de agregación: `sum(l_extendedprice * (1 - l_discount))` y finalmente se ordena el resultado por este resultado de acuerdo al comando **group by**.

Figura 5: Arbol de ejecución de Q13 optimizado

Se pudo observar que de 17826,476 ms que duraba la ejecución de la consulta, se paso a 2923,460 ms y con una lectura desde el sistema operativo de 3020,00 ms . Esto supone una mejora de un 83,60 % con respecto a la consulta original. Cualitativamente se puede considerar la mejora como **muy buena**.

De 98544 páginas leídas en `lineitem` sin soporte de ningún índice se pasó a 7291 páginas leídas con soporte del índice `q13_lineitem_idx` , estos dátos son consistentes con lo calculado previamente. Sin embargo recuperar los datos deseados de lineitem representa un 17 % de la ejecución de la consulta y sigue siendo la más costosa y la mas larga.

Para 'orders tenemos un caso similar: de 25196 páginas leídas sin asistencia de ningún índice, se pasó a leer 223 páginas solamente, lo cual es un poco mas bajo del estimado de 255 páginas.

Segunda iteración

En la Figura 2 se puede observar que antes de realizar la operación de la función de agregación, el manejador debe ordenar mediante un *external sort* las tuplas para luego ejecutar la función de agregación. Este paso es costoso pues debe ordenar en disco.

Dado este problema se propuso aumentar la variable **work_mem** del manejador para ampliar el espacio de la memoria principal donde se ejecuta la consulta. El valor asignado a **work_mem** paso de 4MB a 64MB. En la Figura 3 se puede observar el nuevo árbol de ejecución.
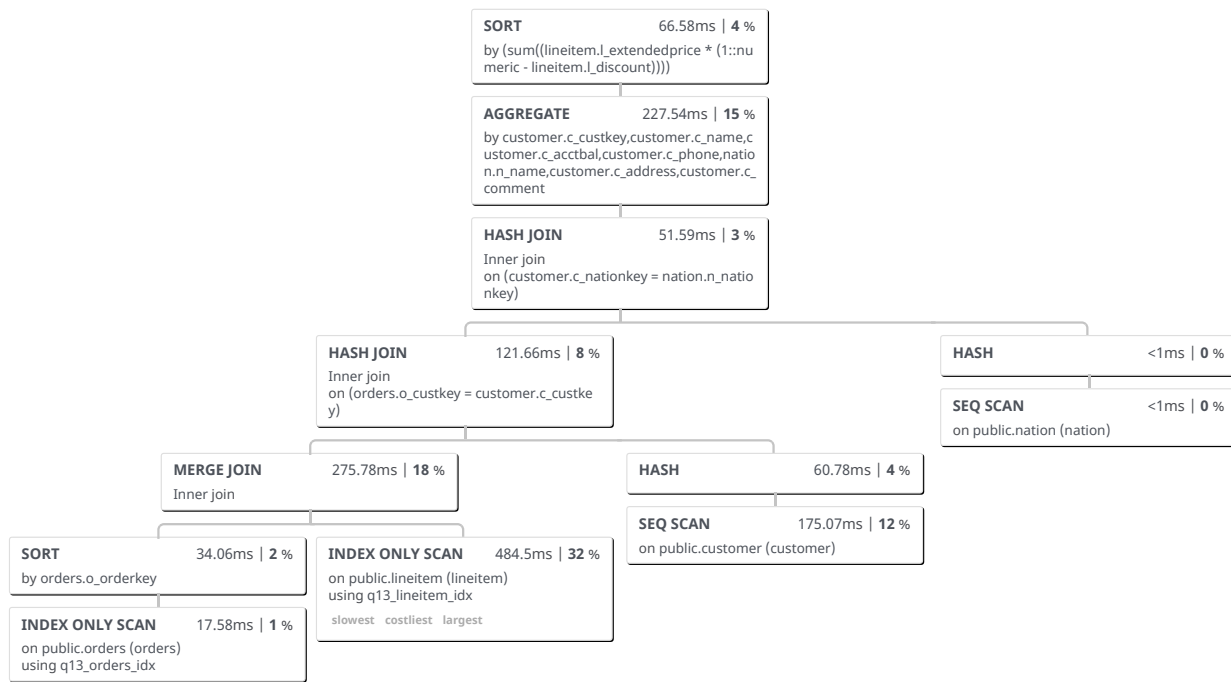
Figura 6: Arbol de ejecución de Q13 optimizada con work_mem=64MB

El arbol de la Figura 6 es similar al de la Figura 4 salvo por el hecho de que se hace un *Index only scan* sobre `lineitem` y `orders` y un *Sequetial scan* sobre las tablas `customer` y `nation` seguido de una proyección basada en hash para extraer los atributos deseados.

En la fase de *joins* se realiza un *Merge Join* entre `customer` y `lineitem` luego se realiza un *Hash Join* entre el resultado anterior y la tabla `customer` para finalmente efectuar un *Hash Join* entre el resultado previo y la tabla `nation`.

Se puede notar que ha desaparecido el nodo de ordenamiento previo que era un *external sort* o un ordenamiento en disco que, dada la lentitud del disco duro con respecto a la memoria principal, es una operación costosa. Se asume que la operación de ordenamiento del **group by** no hizo falta o se realizó *on the fly*.

Con el aumento de la variable `work_mem` de 4MB a 64MB se redujo el tiempo de la consulta de 2923,460 ms a 1466,647 ms lo cual es una mejora en el tiempo de ejecución del 49,83 %

con respecto a la primera optimización. Sin embargo, desde el sistema operativo se reistró una lectura de 1730,00 ms.

Resumen de mejorías

Se pudo observar una notable mejoría en desempeño de la consulta Q13. En la primera iteración se crearon índices que evitaron el acceso a las tablas más grandes de la base de datos reduciendo así la cantidad de accesos a memoria secundaria. Finalmente, en la segunda iteración se aumentó el espacio de memoria de la consulta para eliminar ordenamientos en disco.

Con estas dos iteraciones se logró una reducción del 91,18 % del tiempo de ejecución de la consulta. Sin embargo, no se pudo reducir a menos de un segundo. En la Figura 10 se puede apreciar los cambios.
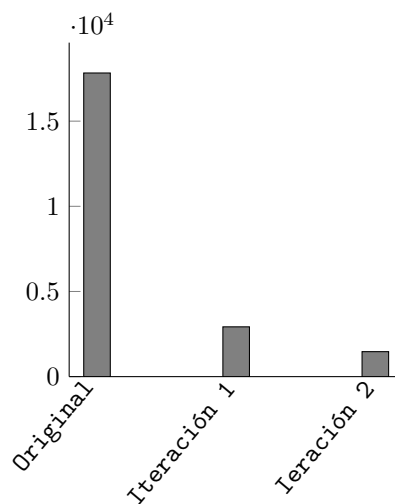
Figura 7: Comparación de tiempos en cada iteración

Consulta Q21: Modos de envío y orden de prioridad

La consulta que se tuvo que optimizar fue la siguiente:

```
prepare q21o as
select l_shipmode,
    sum (case
        when o_orderpriority = '1-URGENT'
        or o_orderpriority = '2-HIGH'
            then 1
            else 0
        end) as high_line_count,
```

```
    sum(case
        when o_orderpriority <> '1-URGENT'
        and o_orderpriority <> '2-HIGH'
            then 1
            else 0
        end) as low_line_count
from orders,lineitem
where o_orderkey = l_orderkey and l_shipmode in ($1, $2)
    and l_commitdate < l_receiptdate and l_shipdate < l_commitdate
    and l_receiptdate >= $3 and l_receiptdate < $3 + interval '1 year'
group by l_shipmode
order by l_shipmode;
```

Todas las pruebas para esta consulta se realizaron con una isntancia dedicada de AWS (Amazon Web Services).

Al ejecutar la consulta sin ningúna estructura adicional se obtuvo el plan de ejecución mostrado en la la Figura 8 . En ella se puede observar que la operación de *scan* sobre la tabla `lineitem` es la operación mas costosa y lenta de toda la consulta, mientras que la operación mas larga fue el *Index scan* sobre la tabla `orders` y se recupera la tupla completa ya ordenada.
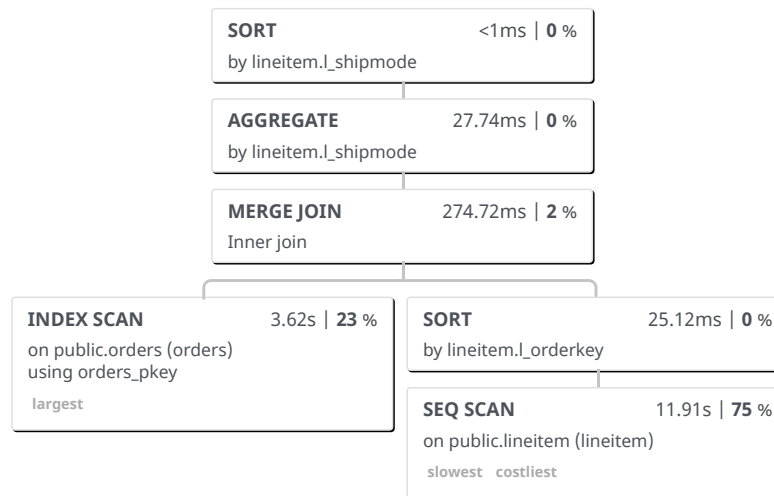
Figura 8: Arbol de ejecucion de la consulta Q21

Justo despues de recuperar las tuplas, para el caso de `lineitem` se realiza un ordenamiento en memoria de las tuplas obtenidas.

En la fase de *joins* tenemos que el manejador escoge un *Merge Join* como opción más barata, dado que ya venía una tabla ordenada, utilizando la condición `o_orderkey = l_orderkey` como criterio.

Finalmente se efectúa la función de agregación y se ordena el resultado por el atributo `l_shipmode` cuyo costo es despreciable.

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El tiempo que se tardó el manejador en producir los resultados fue de 15858,726 ms siendo el *Sequential scan* sobre `lineitem` y el *Index scan* sobre `orders` las operaciones más costosas con 11911,128 ms y 3622,825 ms de duración respectivamente.

Primera iteración:

Dado que los *bottle necks* , o cuellos de botella, de la ejecución de la consulta fueron la obtención de las tuplas correspondientes se enfocó en la primera iteración en la obtención eficiente de los atributos deseados de cada tabla evitando el acceso, si es posible, al archivo que contiene las tablas.

Para la tabla `lineitem` se propone la utilización de un índice compuesto que contenga los siguientes atributos: `l_receiptdate`, `l_commitdate`, `l_shipdate`, `l_shipmode` y `l_orderkey` en el orden especificado.

El tamaño de una tupla con todos estos atributos es, aproximadamente, 21 bytes. Esta información se puede constatar en la Tabla 3. Entonces, el número de páginas estimado del índice sería $98544 \times (21/60) = 34491$.

Para la tabla `orders` se propuso un índice con los siguientes atributos: `o_orderkey` y `o_orderpriority` en ese orden. Este índice permite obtener solo los atributos que se requieren para la consulta sin tener que acceder al archivo principal de la tabla con menos operaciones de entrada salida al solo tener que realizar $25196 \times (13/59) = 5552$ en comparación con 25196 que tendría que hacer sin soporte alguno.

Luego de la de este análisis se procedió a crear los índices:

```
--Elementos para orders
create index q21_orders_idx ON orders(o_orderkey, o_orderpriority);

--Elementos para lineitem
create index q21_lineitem_idx ON lineitem(l_receiptdate, l_commitdate,
l_shipdate, l_shipmode, l_orderkey);
```

Luego se consultó el número de páginas que tenía cada índice con la consulta:

```
select relname,relpages
    from pg_class
    where relname in ('q21_orders_idx','q21_lineitem_idx');
```

obteniendose lo siguiente los de +@tbl:paginas_idx_q21 .

```
 Índice         | Páginas
```

—————————+———- q21_orders_idx | 6108 q21_lineitem_idx | 29755

:Cantidad de páginas de los índices propuestos {#tbl:paginas_idx_q21}

A parte, se reescribió la consulta de la siguiente manera equivalente:

```
prepare q21 as
select l_shipmode,
    count(o_orderpriority) filter(where o_orderpriority in
        ('1-URGENT','2-HIGH') )as high_line_count,
    count(o_orderpriority) filter(where o_orderpriority not in
        ('1-URGENT','2-HIGH') )as low_line_count
from orders,lineitem
where o_orderkey = l_orderkey and l_shipmode in ($1, $2)
    and l_commitdate < l_receiptdate and l_shipdate < l_commitdate
    and l_receiptdate >= $3 and l_receiptdate < $3 + interval '1 year'
group by l_shipmode
order by l_shipmode;
```

Finalmente se procedio a ejecutar la consulta Q21 mejorada para observar que ocurría. El arbol de ejecución con la duración de cada nodo se puede observar en la la Figura 9.
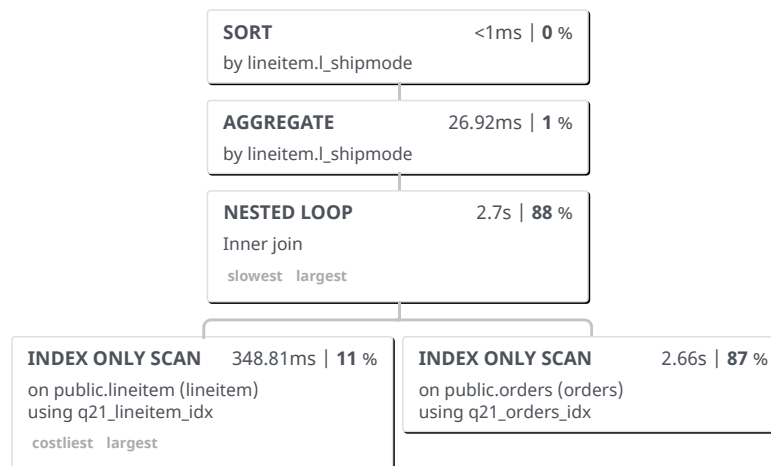
Figura 9: Arbol de ejecucion de la consulta Q21 optimizada

En ella se puede observar que la operación de *Index only scan* sobre la tabla `lineitem`, que paso de durar 11911,128 ms en la consulta original a 348,811 ms.

En la fase de *joins* se utiliza un *Index nested loop join* entre los resultados obtenidos del filtrado de `lineitem` con la tabla `orders` con la condición `o_orderkey = l_orderkey`. El índice utilizado para el join fue el propuesto, en el arbol de ejecución de la Figura 9 se puede observar un *Index only scan* sobre `orders`. Sin embargo, este recorrido secuencial se realiza a la misma vez que se realiza el join.

El resto del plan de ejecución se mantiene intacto.

El tiempo de ejecución de la consulta paso de 15858,726 ms a 3124,659 ms, lo que significa una mejora de 80,3 % con respecto a la consulta original. Cualitativamente, esta mejora se puede considerar **muy buena**.

Adicionalmente, se realizaron pruebas con esta consulta aumentanto el tamaño de la variable `work_mem` per no hubo mejoría notable en la misma. En +@fig:q21chart se puede apreciar la mejora en tiempo de ejecución de la consulta
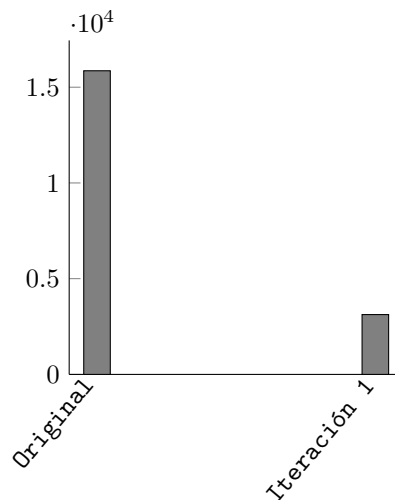
Figura 10: Comparación de tiempos en cada iteración

Consulta Q22: Relación parte/proveedor

Consulta Q23: Oportunidad de ventas globales

La consulta a optimizar es la siguiente:

```sql
select
  cntrycode,
  count(*) as numcust,
  sum(c_acctbal) as totacctbal
from (
  select
    substring(c_phone from 1 for 2) as cntrycode,
    c_acctbal
  from
    customer
  where
    substring(c_phone from 1 for 2) in
```

```
        ($1, $2, $3, $4, $5, $6, $7)
    and c_acctbal > (
      select
        avg(c_acctbal)
      from
        customer
      where
        c_acctbal > 0.00
        and substring(c_phone from 1 for 2) in
          ($1, $2, $3, $4, $5, $6, $7)
    )
    and not exists (
      select
        *
      from
        orders
      where
        o_custkey = c_custkey
    )
  ) as custsale
group by
  cntrycode
order by
  cntrycode;
```

Al hacer `Explain Analyze` sobre la consulta sin ningúna estructura adicional se obtuvo el plan de ejecución mostrado en la Figura 11, con una duración total de 3018 ms. Puede verse que el nodo más caro y lento en este grafo fue el *Seq Scan* (2167 ms) que se hace sobre `orders` como parte del *Hash Anti Join* con la tabla `customer` sobre la igualdad de los atributos `c_custkey` y `o_custkey`, cuyos nombres indican que se trata de un join sobre una clave foránea entre la entidad `order` y su `customer` correspondiente. Como se trata de un *Anti Join*, sólo sobreviven las filas de `customer` que **no** tienen filas correspondientes en `orders`, pero el algoritmo para calcular esta operación es muy similar al usual del *Hash Join*.

Cabe mencionar que la consulta fue reescrita para facilitar su interpretación, sin que esto cambiara su semántica ni su eficiencia. Esta reescritura produjo la siguiente consulta:

```
select
  substring(c_phone from 1 for 2) as cntrycode,
  count(1)                        as numcust,
  sum(c_acctbal)                  as totacctbal
from
  customer
where substring(c_phone from 1 for 2) in
    ($1, $2, $3, $4, $5, $6, $7)
```
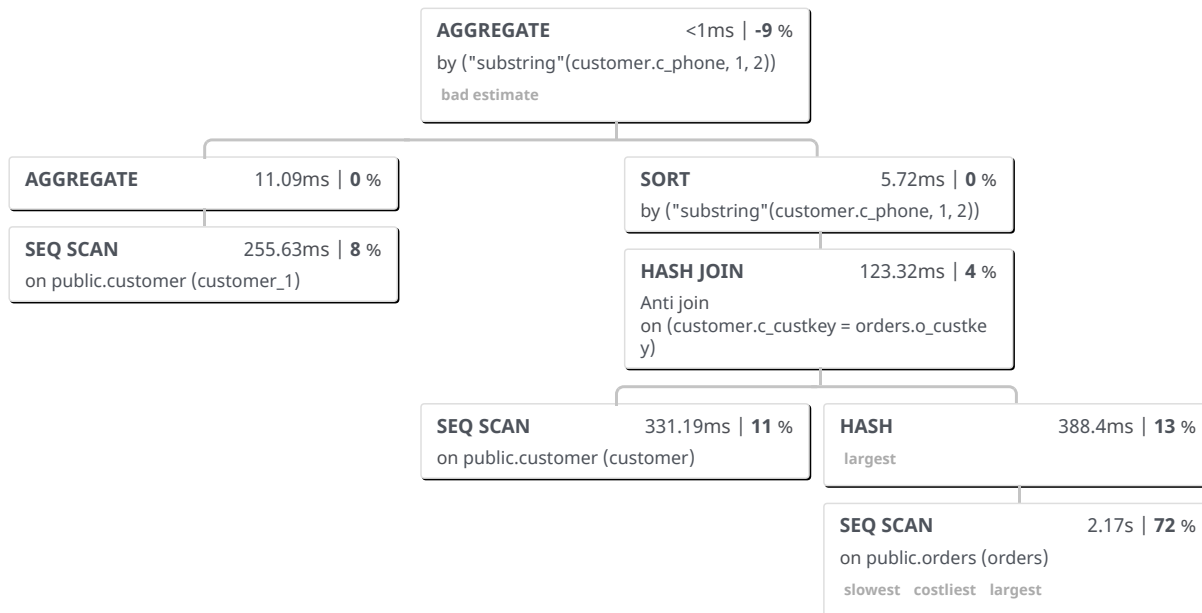
Figura 11: Arbol de ejecucion de la consulta Q23 original

```sql
and c_acctbal > (
  select
    avg(c_acctbal)
  from
    customer
  where substring(c_phone from 1 for 2) in
      ($1, $2, $3, $4, $5, $6, $7)
    and c_acctbal > 0.00
)
and not exists (
  select 1
  from
    orders
  where
    o_custkey = c_custkey
)
group by
  cntrycode
order by
  cntrycode;
```

Básicamente, se simplificó la estructura de la consulta, dejando la consulta interna con las selecciones, agrupaciones y ordenamientos de la externa. Cabe mencionar que, a pesar de que la parte

```
and not exists (
  select 1
from
  orders
where
  o_custkey = c_custkey
)
```

de la consulta podría sugerir ineficiencia, pues tiene la estructura de una consulta correlacionada, este no es el caso, y de hecho reescribir esto como una *Common Table Expression* resultaría en una consulta menos eficiente, pues el *Anti Join* se convertiría en una costosa diferencia de conjuntos.

Posterior a esto, se crearon dos índices para mejorar el rendimiento de esta consulta. El primero, creado sobre la tabla `customer`, sobre los primeros 2 dígitos del número de teléfono del cliente y sobre su balance de cuentas, permite al manejador conseguir primero los clientes con un prefijo telefónico específico y luego los que tengan un balance de cuentas en un rango particular. Los atributos del índice están en este órden porque invertirlos no permitiría hacer búsquedas por igualdad en los primeros 2 dígitos del número de teléfono, que es lo que se desea en esta consulta. Este índice fue creado con el siguiente comando:

```
create index idx_q23_c_ctrycode_acctbal
  on customer (substring(c_phone from 1 for 2), c_acctbal);
```

El segundo índice que agregamos para esta consulta es sobre la tabla `orders`, en el atributo `o_custkey`. Parece un índice muy sencillo y su impacto no necesariamente es obvio, pero permite conseguir rápidamente las órdenes correspondientes a un cliente en particular. En el caso de esta consulta, interesa conocer los clientes *sin* órdenes, para lo cual este índice resulta aún más conveniente: basta una búsqueda *Index Only* sobre este índice para saber cuáles son los clientes que no están representados en esta tabla, y se hace innecesario recuperar información directamente de la tabla `orders`. Este índice fue creado con el siguiente comando:

```
create index idx_q23_o_custkey
  on orders (o_custkey);
```

Luego de la creación del par de índices, el tiempo de ejecución (con caché fría) de esta consulta baja de 3018 ms a 379 ms, tan sólo el 12.5 % del tiempo de la consulta original. El plan resultante es el mostrado en la Figura 12.
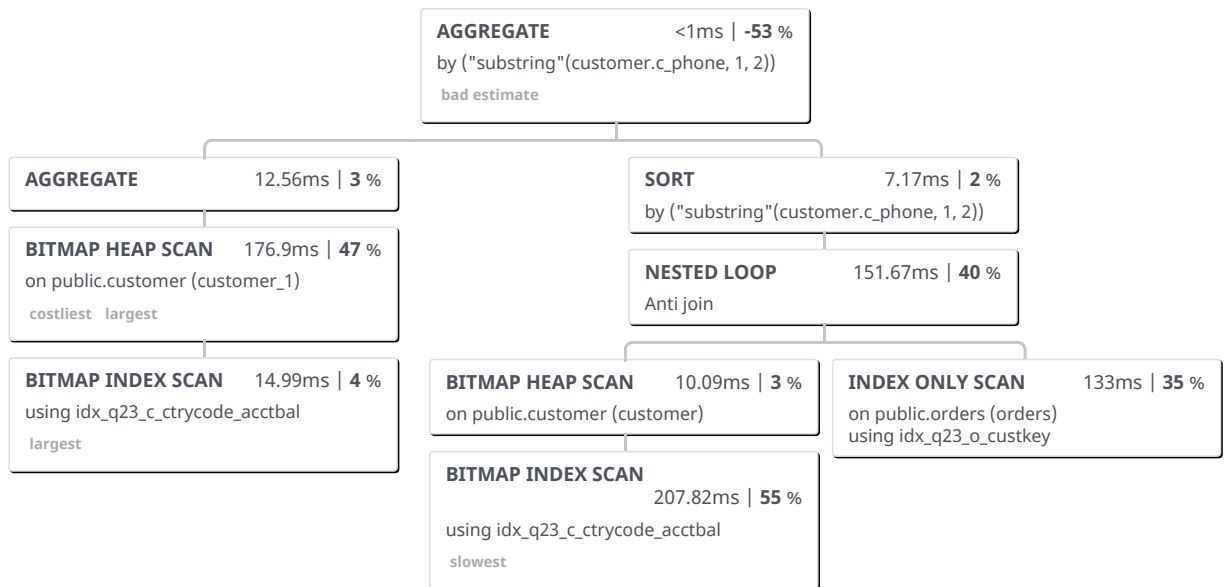
Figura 12: Arbol de ejecucion de la consulta Q23 modificada (a)

Conclusiones

Anexos

Resultados Q11

Original

Text

Yaml

```yaml
- Plan:
    Node Type: "Sort"
    Startup Cost: 39836.85
    Total Cost: 39836.86
    Plan Rows: 1
    Plan Width: 180
    Actual Startup Time: 1992.349
    Actual Total Time: 1992.411
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "supplier.s_acctbal"
      - "supplier.s_name"
      - "nation.n_name"
      - "part.p_partkey"
      - "part.p_mfgr"
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
    Sort Key:
      - "supplier.s_acctbal"
      - "nation.n_name"
      - "supplier.s_name"
      - "part.p_partkey"
    Sort Method: "quicksort"
    Sort Space Used: 146
    Sort Space Type: "Memory"
    Shared Hit Blocks: 19749
    Shared Read Blocks: 22870
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
```

```
Local Written Blocks: 0
Temp Read Blocks: 3241
Temp Written Blocks: 3246
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Merge Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 29112.01
    Total Cost: 39836.84
    Plan Rows: 1
    Plan Width: 180
    Actual Startup Time: 1349.229
    Actual Total Time: 1991.364
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "supplier.s_acctbal"
      - "supplier.s_name"
      - "nation.n_name"
      - "part.p_partkey"
      - "part.p_mfgr"
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
    Merge Cond: "(part.p_partkey = partsupp.ps_partkey)"
    Join Filter: "(partsupp.ps_supplycost = (SubPlan 1))"
    Rows Removed by Join Filter: 182
    Shared Hit Blocks: 19739
    Shared Read Blocks: 22870
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 3241
    Temp Written Blocks: 3246
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Index Scan"
        Parent Relationship: "Outer"
        Scan Direction: "Forward"
```

```
Index Name: "part_pkey"
Relation Name: "part"
Schema: "public"
Alias: "part"
Startup Cost: 0.42
Total Cost: 9924.12
Plan Rows: 824
Plan Width: 19
Actual Startup Time: 0.496
Actual Total Time: 108.881
Actual Rows: 747
Actual Loops: 1
Output:
  - "part.p_partkey"
  - "part.p_name"
  - "part.p_mfgr"
  - "part.p_brand"
  - "part.p_type"
  - "part.p_size"
  - "part.p_container"
  - "part.p_retailprice"
  - "part.p_comment"
Filter: "((part.p_type ~~ '%BRASS'::text) AND (part.p_size = 15))"
Rows Removed by Filter: 199253
Shared Hit Blocks: 42
Shared Read Blocks: 4258
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Sort"
  Parent Relationship: "Inner"
  Startup Cost: 29111.59
  Total Cost: 29121.21
  Plan Rows: 3848
  Plan Width: 171
  Actual Startup Time: 1347.415
  Actual Total Time: 1393.986
  Actual Rows: 158755
```

```
Actual Loops: 1
Output:
  - "supplier.s_acctbal"
  - "supplier.s_name"
  - "supplier.s_address"
  - "supplier.s_phone"
  - "supplier.s_comment"
  - "partsupp.ps_partkey"
  - "partsupp.ps_supplycost"
  - "nation.n_name"
Sort Key:
  - "partsupp.ps_partkey"
Sort Method: "external sort"
Sort Space Used: 25968
Sort Space Type: "Disk"
Shared Hit Blocks: 4
Shared Read Blocks: 17662
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 3241
Temp Written Blocks: 3246
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 393.12
    Total Cost: 28882.45
    Plan Rows: 3848
    Plan Width: 171
    Actual Startup Time: 10.963
    Actual Total Time: 1169.030
    Actual Rows: 158960
    Actual Loops: 1
    Output:
      - "supplier.s_acctbal"
      - "supplier.s_name"
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
```

```
    - "partsupp.ps_partkey"
    - "partsupp.ps_supplycost"
    - "nation.n_name"
Hash Cond: "(partsupp.ps_suppkey = supplier.s_suppkey)"
Shared Hit Blocks: 4
Shared Read Blocks: 17662
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "partsupp"
    Schema: "public"
    Alias: "partsupp"
    Startup Cost: 0.00
    Total Cost: 25451.00
    Plan Rows: 800000
    Plan Width: 14
    Actual Startup Time: 0.002
    Actual Total Time: 906.478
    Actual Rows: 800000
    Actual Loops: 1
    Output:
      - "partsupp.ps_partkey"
      - "partsupp.ps_suppkey"
      - "partsupp.ps_availqty"
      - "partsupp.ps_supplycost"
      - "partsupp.ps_comment"
    Shared Hit Blocks: 2
    Shared Read Blocks: 17449
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
```

```
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
  - Node Type: "Hash"
    Parent Relationship: "Inner"
    Startup Cost: 392.51
    Total Cost: 392.51
    Plan Rows: 48
    Plan Width: 165
    Actual Startup Time: 10.940
    Actual Total Time: 10.940
    Actual Rows: 1987
    Actual Loops: 1
    Output:
      - "supplier.s_acctbal"
      - "supplier.s_name"
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
      - "supplier.s_suppkey"
      - "nation.n_name"
    Hash Buckets: 1024
    Hash Batches: 1
    Original Hash Batches: 1
    Peak Memory Usage: 346
    Shared Hit Blocks: 2
    Shared Read Blocks: 213
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Hash Join"
        Parent Relationship: "Outer"
        Join Type: "Inner"
        Startup Cost: 41.52
        Total Cost: 392.51
        Plan Rows: 48
        Plan Width: 165
```

```
Actual Startup Time: 0.689
Actual Total Time: 9.914
Actual Rows: 1987
Actual Loops: 1
Output:
  - "supplier.s_acctbal"
  - "supplier.s_name"
  - "supplier.s_address"
  - "supplier.s_phone"
  - "supplier.s_comment"
  - "supplier.s_suppkey"
  - "nation.n_name"
Hash Cond: "(supplier.s_nationkey = nation.n_nationkey)"
Shared Hit Blocks: 2
Shared Read Blocks: 213
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "supplier"
    Schema: "public"
    Alias: "supplier"
    Startup Cost: 0.00
    Total Cost: 313.00
    Plan Rows: 10000
    Plan Width: 137
    Actual Startup Time: 0.001
    Actual Total Time: 6.651
    Actual Rows: 10000
    Actual Loops: 1
    Output:
      - "supplier.s_suppkey"
      - "supplier.s_name"
      - "supplier.s_address"
      - "supplier.s_nationkey"
      - "supplier.s_phone"
```

```
              - "supplier.s_acctbal"
              - "supplier.s_comment"
           Shared Hit Blocks: 2
           Shared Read Blocks: 211
           Shared Dirtied Blocks: 0
           Shared Written Blocks: 0
           Local Hit Blocks: 0
           Local Read Blocks: 0
           Local Dirtied Blocks: 0
           Local Written Blocks: 0
           Temp Read Blocks: 0
           Temp Written Blocks: 0
           I/O Read Time: 0.000
           I/O Write Time: 0.000
         - Node Type: "Hash"
           Parent Relationship: "Inner"
           Startup Cost: 41.47
           Total Cost: 41.47
           Plan Rows: 4
           Plan Width: 36
           Actual Startup Time: 0.677
           Actual Total Time: 0.677
           Actual Rows: 5
           Actual Loops: 1
           Output:
              - "nation.n_name"
              - "nation.n_nationkey"
           Hash Buckets: 1024
           Hash Batches: 1
           Original Hash Batches: 1
           Peak Memory Usage: 1
           Shared Hit Blocks: 0
           Shared Read Blocks: 2
           Shared Dirtied Blocks: 0
           Shared Written Blocks: 0
           Local Hit Blocks: 0
           Local Read Blocks: 0
           Local Dirtied Blocks: 0
           Local Written Blocks: 0
           Temp Read Blocks: 0
           Temp Written Blocks: 0
           I/O Read Time: 0.000
           I/O Write Time: 0.000
           Plans:
              - Node Type: "Hash Join"
```

```
Parent Relationship: "Outer"
Join Type: "Inner"
Startup Cost: 20.43
Total Cost: 41.47
Plan Rows: 4
Plan Width: 36
Actual Startup Time: 0.666
Actual Total Time: 0.675
Actual Rows: 5
Actual Loops: 1
Output:
  - "nation.n_name"
  - "nation.n_nationkey"
Hash Cond: "(nation.n_regionkey = region.r_regionkey)"
Shared Hit Blocks: 0
Shared Read Blocks: 2
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "nation"
    Schema: "public"
    Alias: "nation"
    Startup Cost: 0.00
    Total Cost: 18.00
    Plan Rows: 800
    Plan Width: 40
    Actual Startup Time: 0.351
    Actual Total Time: 0.360
    Actual Rows: 25
    Actual Loops: 1
    Output:
      - "nation.n_nationkey"
      - "nation.n_name"
      - "nation.n_regionkey"
      - "nation.n_comment"
```

```
Shared Hit Blocks: 0
Shared Read Blocks: 1
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Hash"
  Parent Relationship: "Inner"
  Startup Cost: 20.38
  Total Cost: 20.38
  Plan Rows: 4
  Plan Width: 4
  Actual Startup Time: 0.303
  Actual Total Time: 0.303
  Actual Rows: 1
  Actual Loops: 1
  Output:
    - "region.r_regionkey"
  Hash Buckets: 1024
  Hash Batches: 1
  Original Hash Batches: 1
  Peak Memory Usage: 1
  Shared Hit Blocks: 0
  Shared Read Blocks: 1
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 0
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Seq Scan"
      Parent Relationship: "Outer"
      Relation Name: "region"
      Schema: "public"
```

```
                                              Alias: "region"
                                              Startup Cost: 0.00
                                              Total Cost: 20.38
                                              Plan Rows: 4
                                              Plan Width: 4
                                              Actual Startup Time: 0.301
                                              Actual Total Time: 0.302
                                              Actual Rows: 1
                                              Actual Loops: 1
                                              Output:
                                                - "region.r_regionkey"
                                              Filter: "(region.r_name = 'EUROPE'::text)"
                                              Rows Removed by Filter: 4
                                              Shared Hit Blocks: 0
                                              Shared Read Blocks: 1
                                              Shared Dirtied Blocks: 0
                                              Shared Written Blocks: 0
                                              Local Hit Blocks: 0
                                              Local Read Blocks: 0
                                              Local Dirtied Blocks: 0
                                              Local Written Blocks: 0
                                              Temp Read Blocks: 0
                                              Temp Written Blocks: 0
                                              I/O Read Time: 0.000
                                              I/O Write Time: 0.000
               - Node Type: "Aggregate"
                 Strategy: "Plain"
                 Parent Relationship: "SubPlan"
                 Subplan Name: "SubPlan 1"
                 Startup Cost: 48.72
                 Total Cost: 48.73
                 Plan Rows: 1
                 Plan Width: 6
                 Actual Startup Time: 0.708
                 Actual Total Time: 0.708
                 Actual Rows: 1
                 Actual Loops: 642
                 Output:
                   - "min(partsupp_1.ps_supplycost)"
                 Shared Hit Blocks: 19693
                 Shared Read Blocks: 950
                 Shared Dirtied Blocks: 0
                 Shared Written Blocks: 0
                 Local Hit Blocks: 0
                 Local Read Blocks: 0
```

```
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 1.01
    Total Cost: 48.71
    Plan Rows: 1
    Plan Width: 6
    Actual Startup Time: 0.685
    Actual Total Time: 0.705
    Actual Rows: 2
    Actual Loops: 642
    Output:
      - "partsupp_1.ps_supplycost"
    Shared Hit Blocks: 19693
    Shared Read Blocks: 950
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Nested Loop"
        Parent Relationship: "Outer"
        Join Type: "Inner"
        Startup Cost: 0.86
        Total Cost: 47.74
        Plan Rows: 4
        Plan Width: 10
        Actual Startup Time: 0.674
        Actual Total Time: 0.697
        Actual Rows: 4
        Actual Loops: 642
        Output:
```

```
          - "partsupp_1.ps_supplycost"
          - "nation_1.n_regionkey"
  Shared Hit Blocks: 14558
  Shared Read Blocks: 949
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 0
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Nested Loop"
      Parent Relationship: "Outer"
      Join Type: "Inner"
      Startup Cost: 0.71
      Total Cost: 47.01
      Plan Rows: 4
      Plan Width: 10
      Actual Startup Time: 0.672
      Actual Total Time: 0.689
      Actual Rows: 4
      Actual Loops: 642
      Output:
        - "partsupp_1.ps_supplycost"
        - "supplier_1.s_nationkey"
      Shared Hit Blocks: 9423
      Shared Read Blocks: 948
      Shared Dirtied Blocks: 0
      Shared Written Blocks: 0
      Local Hit Blocks: 0
      Local Read Blocks: 0
      Local Dirtied Blocks: 0
      Local Written Blocks: 0
      Temp Read Blocks: 0
      Temp Written Blocks: 0
      I/O Read Time: 0.000
      I/O Write Time: 0.000
      Plans:
        - Node Type: "Index Scan"
          Parent Relationship: "Outer"
          Scan Direction: "Forward"
```

```
Index Name: "partsupp_pkey"
Relation Name: "partsupp"
Schema: "public"
Alias: "partsupp_1"
Startup Cost: 0.42
Total Cost: 13.75
Plan Rows: 4
Plan Width: 10
Actual Startup Time: 0.667
Actual Total Time: 0.671
Actual Rows: 4
Actual Loops: 642
Output:
  - "partsupp_1.ps_partkey"
  - "partsupp_1.ps_suppkey"
  - "partsupp_1.ps_availqty"
  - "partsupp_1.ps_supplycost"
  - "partsupp_1.ps_comment"
Index Cond: "(part.p_partkey = partsupp_1.ps_partkey)"
Rows Removed by Index Recheck: 0
Shared Hit Blocks: 1731
Shared Read Blocks: 922
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Index Scan"
  Parent Relationship: "Inner"
  Scan Direction: "Forward"
  Index Name: "supplier_pkey"
  Relation Name: "supplier"
  Schema: "public"
  Alias: "supplier_1"
  Startup Cost: 0.29
  Total Cost: 8.30
  Plan Rows: 1
  Plan Width: 8
  Actual Startup Time: 0.003
  Actual Total Time: 0.003
```

```
                    Actual Rows: 1
                    Actual Loops: 2568
                    Output:
                       - "supplier_1.s_suppkey"
                       - "supplier_1.s_name"
                       - "supplier_1.s_address"
                       - "supplier_1.s_nationkey"
                       - "supplier_1.s_phone"
                       - "supplier_1.s_acctbal"
                       - "supplier_1.s_comment"
                    Index Cond: "(supplier_1.s_suppkey = partsupp_1.ps_suppkey)"
                    Rows Removed by Index Recheck: 0
                    Shared Hit Blocks: 7692
                    Shared Read Blocks: 26
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
                 - Node Type: "Index Scan"
                   Parent Relationship: "Inner"
                   Scan Direction: "Forward"
                   Index Name: "nation_pkey"
                   Relation Name: "nation"
                   Schema: "public"
                   Alias: "nation_1"
                   Startup Cost: 0.15
                   Total Cost: 0.17
                   Plan Rows: 1
                   Plan Width: 8
                   Actual Startup Time: 0.001
                   Actual Total Time: 0.001
                   Actual Rows: 1
                   Actual Loops: 2568
                   Output:
                      - "nation_1.n_nationkey"
                      - "nation_1.n_name"
                      - "nation_1.n_regionkey"
                      - "nation_1.n_comment"
                   Index Cond: "(nation_1.n_nationkey = supplier_1.s_nationkey)"
```

```
        Rows Removed by Index Recheck: 0
        Shared Hit Blocks: 5135
        Shared Read Blocks: 1
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
  - Node Type: "Index Scan"
    Parent Relationship: "Inner"
    Scan Direction: "Forward"
    Index Name: "region_pkey"
    Relation Name: "region"
    Schema: "public"
    Alias: "region_1"
    Startup Cost: 0.15
    Total Cost: 0.23
    Plan Rows: 1
    Plan Width: 4
    Actual Startup Time: 0.001
    Actual Total Time: 0.001
    Actual Rows: 0
    Actual Loops: 2568
    Output:
      - "region_1.r_regionkey"
      - "region_1.r_name"
      - "region_1.r_comment"
    Index Cond: "(region_1.r_regionkey = nation_1.n_regionkey)"
    Rows Removed by Index Recheck: 0
    Filter: "(region_1.r_name = 'EUROPE'::text)"
    Rows Removed by Filter: 1
    Shared Hit Blocks: 5135
    Shared Read Blocks: 1
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
```

```
                      Temp Written Blocks: 0
                      I/O Read Time: 0.000
                      I/O Write Time: 0.000
  Triggers:
  Execution Time: 1996.111
```

Mejorado

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 7475.13
    Total Cost: 7475.14
    Plan Rows: 1
    Plan Width: 156
    Actual Startup Time: 334.882
    Actual Total Time: 334.925
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "supplier.s_acctbal"
      - "supplier.s_name"
      - "nation.n_name"
      - "part.p_partkey"
      - "part.p_mfgr"
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
    Sort Key:
      - "supplier.s_acctbal"
      - "nation.n_name"
      - "supplier.s_name"
      - "part.p_partkey"
    Sort Method: "quicksort"
    Sort Space Used: 146
    Sort Space Type: "Memory"
    Shared Hit Blocks: 6188
    Shared Read Blocks: 1390
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
```

```
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Sorted"
    Parent Relationship: "InitPlan"
    Subplan Name: "CTE minperpart"
    Startup Cost: 5516.73
    Total Cost: 5527.48
    Plan Rows: 614
    Plan Width: 10
    Actual Startup Time: 318.647
    Actual Total Time: 319.235
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "min(partsupp_1.ps_supplycost)"
      - "partsupp_1.ps_partkey"
    Group Key:
      - "partsupp_1.ps_partkey"
    Shared Hit Blocks: 1579
    Shared Read Blocks: 1364
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Sort"
        Parent Relationship: "Outer"
        Startup Cost: 5516.73
        Total Cost: 5518.27
        Plan Rows: 614
        Plan Width: 10
        Actual Startup Time: 318.635
```

```
Actual Total Time: 318.794
Actual Rows: 642
Actual Loops: 1
Output:
  - "partsupp_1.ps_partkey"
  - "partsupp_1.ps_supplycost"
Sort Key:
  - "partsupp_1.ps_partkey"
Sort Method: "quicksort"
Sort Space Used: 55
Sort Space Type: "Memory"
Shared Hit Blocks: 1579
Shared Read Blocks: 1364
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 428.59
    Total Cost: 5488.30
    Plan Rows: 614
    Plan Width: 10
    Actual Startup Time: 13.257
    Actual Total Time: 318.104
    Actual Rows: 642
    Actual Loops: 1
    Output:
      - "partsupp_1.ps_partkey"
      - "partsupp_1.ps_supplycost"
    Hash Cond: "(partsupp_1.ps_suppkey = supplier_1.s_suppkey)"
    Shared Hit Blocks: 1579
    Shared Read Blocks: 1364
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
```

```
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 30.55
    Total Cost: 5068.75
    Plan Rows: 3076
    Plan Width: 14
    Actual Startup Time: 3.643
    Actual Total Time: 306.543
    Actual Rows: 2988
    Actual Loops: 1
    Output:
      - "partsupp_1.ps_partkey"
      - "partsupp_1.ps_supplycost"
      - "partsupp_1.ps_suppkey"
    Shared Hit Blocks: 1575
    Shared Read Blocks: 1153
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Bitmap Heap Scan"
        Parent Relationship: "Outer"
        Relation Name: "part"
        Schema: "public"
        Alias: "part_1"
        Startup Cost: 30.13
        Total Cost: 1913.64
        Plan Rows: 769
        Plan Width: 4
        Actual Startup Time: 2.620
```

```
Actual Total Time: 21.925
Actual Rows: 747
Actual Loops: 1
Output:
  - "part_1.p_partkey"
  - "part_1.p_name"
  - "part_1.p_mfgr"
  - "part_1.p_brand"
  - "part_1.p_type"
  - "part_1.p_size"
  - "part_1.p_container"
  - "part_1.p_retailprice"
  - "part_1.p_comment"
Recheck Cond: "(part_1.p_size = 15)"
Rows Removed by Index Recheck: 0
Filter: "(reverse(part_1.p_type) ~~ 'SSARB%'::text)"
Rows Removed by Filter: 0
Exact Heap Blocks: 468
Lossy Heap Blocks: 0
Shared Hit Blocks: 2
Shared Read Blocks: 473
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Bitmap Index Scan"
    Parent Relationship: "Outer"
    Index Name: "idx_q11_p_size_reverse_type"
    Startup Cost: 0.00
    Total Cost: 29.94
    Plan Rows: 761
    Plan Width: 0
    Actual Startup Time: 2.113
    Actual Total Time: 2.113
    Actual Rows: 747
    Actual Loops: 1
    Index Cond: "((part_1.p_size = 15) AND (reverse(part_1.p_typ
    Shared Hit Blocks: 0
```

```
         Shared Read Blocks: 7
         Shared Dirtied Blocks: 0
         Shared Written Blocks: 0
         Local Hit Blocks: 0
         Local Read Blocks: 0
         Local Dirtied Blocks: 0
         Local Written Blocks: 0
         Temp Read Blocks: 0
         Temp Written Blocks: 0
         I/O Read Time: 0.000
         I/O Write Time: 0.000
 - Node Type: "Index Only Scan"
   Parent Relationship: "Inner"
   Scan Direction: "Forward"
   Index Name: "idx_q11_partsupp"
   Relation Name: "partsupp"
   Schema: "public"
   Alias: "partsupp_1"
   Startup Cost: 0.42
   Total Cost: 4.06
   Plan Rows: 4
   Plan Width: 14
   Actual Startup Time: 0.374
   Actual Total Time: 0.378
   Actual Rows: 4
   Actual Loops: 747
   Output:
     - "partsupp_1.ps_partkey"
     - "partsupp_1.ps_suppkey"
     - "partsupp_1.ps_supplycost"
   Index Cond: "(partsupp_1.ps_partkey = part_1.p_partkey)"
   Rows Removed by Index Recheck: 0
   Heap Fetches: 0
   Shared Hit Blocks: 1573
   Shared Read Blocks: 680
   Shared Dirtied Blocks: 0
   Shared Written Blocks: 0
   Local Hit Blocks: 0
   Local Read Blocks: 0
   Local Dirtied Blocks: 0
   Local Written Blocks: 0
   Temp Read Blocks: 0
   Temp Written Blocks: 0
   I/O Read Time: 0.000
   I/O Write Time: 0.000
```

```
- Node Type: "Hash"
  Parent Relationship: "Inner"
  Startup Cost: 373.03
  Total Cost: 373.03
  Plan Rows: 2000
  Plan Width: 4
  Actual Startup Time: 9.600
  Actual Total Time: 9.600
  Actual Rows: 1987
  Actual Loops: 1
  Output:
    - "supplier_1.s_suppkey"
  Hash Buckets: 1024
  Hash Batches: 1
  Original Hash Batches: 1
  Peak Memory Usage: 70
  Shared Hit Blocks: 4
  Shared Read Blocks: 211
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 0
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Hash Join"
      Parent Relationship: "Outer"
      Join Type: "Inner"
      Startup Cost: 2.53
      Total Cost: 373.03
      Plan Rows: 2000
      Plan Width: 4
      Actual Startup Time: 0.041
      Actual Total Time: 9.026
      Actual Rows: 1987
      Actual Loops: 1
      Output:
        - "supplier_1.s_suppkey"
      Hash Cond: "(supplier_1.s_nationkey = nation_1.n_nationkey)"
      Shared Hit Blocks: 4
      Shared Read Blocks: 211
```

```
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "supplier"
    Schema: "public"
    Alias: "supplier_1"
    Startup Cost: 0.00
    Total Cost: 313.00
    Plan Rows: 10000
    Plan Width: 8
    Actual Startup Time: 0.003
    Actual Total Time: 6.271
    Actual Rows: 10000
    Actual Loops: 1
    Output:
      - "supplier_1.s_suppkey"
      - "supplier_1.s_name"
      - "supplier_1.s_address"
      - "supplier_1.s_nationkey"
      - "supplier_1.s_phone"
      - "supplier_1.s_acctbal"
      - "supplier_1.s_comment"
    Shared Hit Blocks: 2
    Shared Read Blocks: 211
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
  - Node Type: "Hash"
```

```
Parent Relationship: "Inner"
Startup Cost: 2.47
Total Cost: 2.47
Plan Rows: 5
Plan Width: 4
Actual Startup Time: 0.026
Actual Total Time: 0.026
Actual Rows: 5
Actual Loops: 1
Output:
  - "nation_1.n_nationkey"
Hash Buckets: 1024
Hash Batches: 1
Original Hash Batches: 1
Peak Memory Usage: 1
Shared Hit Blocks: 2
Shared Read Blocks: 0
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 1.07
    Total Cost: 2.47
    Plan Rows: 5
    Plan Width: 4
    Actual Startup Time: 0.016
    Actual Total Time: 0.023
    Actual Rows: 5
    Actual Loops: 1
    Output:
      - "nation_1.n_nationkey"
    Hash Cond: "(nation_1.n_regionkey = region_1.r_regionkey
    Shared Hit Blocks: 2
    Shared Read Blocks: 0
    Shared Dirtied Blocks: 0
```

```
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "nation"
    Schema: "public"
    Alias: "nation_1"
    Startup Cost: 0.00
    Total Cost: 1.25
    Plan Rows: 25
    Plan Width: 8
    Actual Startup Time: 0.001
    Actual Total Time: 0.004
    Actual Rows: 25
    Actual Loops: 1
    Output:
      - "nation_1.n_nationkey"
      - "nation_1.n_name"
      - "nation_1.n_regionkey"
      - "nation_1.n_comment"
    Shared Hit Blocks: 1
    Shared Read Blocks: 0
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
  - Node Type: "Hash"
    Parent Relationship: "Inner"
    Startup Cost: 1.06
    Total Cost: 1.06
    Plan Rows: 1
```

```
Plan Width: 4
Actual Startup Time: 0.005
Actual Total Time: 0.005
Actual Rows: 1
Actual Loops: 1
Output:
  - "region_1.r_regionkey"
Hash Buckets: 1024
Hash Batches: 1
Original Hash Batches: 1
Peak Memory Usage: 1
Shared Hit Blocks: 1
Shared Read Blocks: 0
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "region"
    Schema: "public"
    Alias: "region_1"
    Startup Cost: 0.00
    Total Cost: 1.06
    Plan Rows: 1
    Plan Width: 4
    Actual Startup Time: 0.003
    Actual Total Time: 0.003
    Actual Rows: 1
    Actual Loops: 1
    Output:
      - "region_1.r_regionkey"
    Filter: "(region_1.r_name = 'EUROPE'::text)"
    Rows Removed by Filter: 4
    Shared Hit Blocks: 1
    Shared Read Blocks: 0
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
```

```
                                               Local Hit Blocks: 0
                                               Local Read Blocks: 0
                                               Local Dirtied Blocks: 0
                                               Local Written Blocks: 0
                                               Temp Read Blocks: 0
                                               Temp Written Blocks: 0
                                               I/O Read Time: 0.000
                                               I/O Write Time: 0.000
        - Node Type: "Nested Loop"
          Parent Relationship: "Outer"
          Join Type: "Inner"
          Startup Cost: 1924.10
          Total Cost: 1947.64
          Plan Rows: 1
          Plan Width: 156
          Actual Startup Time: 320.408
          Actual Total Time: 333.999
          Actual Rows: 460
          Actual Loops: 1
          Output:
            - "supplier.s_acctbal"
            - "supplier.s_name"
            - "nation.n_name"
            - "part.p_partkey"
            - "part.p_mfgr"
            - "supplier.s_address"
            - "supplier.s_phone"
            - "supplier.s_comment"
          Shared Hit Blocks: 6175
          Shared Read Blocks: 1390
          Shared Dirtied Blocks: 0
          Shared Written Blocks: 0
          Local Hit Blocks: 0
          Local Read Blocks: 0
          Local Dirtied Blocks: 0
          Local Written Blocks: 0
          Temp Read Blocks: 0
          Temp Written Blocks: 0
          I/O Read Time: 0.000
          I/O Write Time: 0.000
          Plans:
            - Node Type: "Nested Loop"
              Parent Relationship: "Outer"
              Join Type: "Inner"
              Startup Cost: 1924.10
```

```
Total Cost: 1946.57
Plan Rows: 1
Plan Width: 156
Actual Startup Time: 320.398
Actual Total Time: 332.995
Actual Rows: 460
Actual Loops: 1
Output:
  - "part.p_partkey"
  - "part.p_mfgr"
  - "supplier.s_acctbal"
  - "supplier.s_name"
  - "supplier.s_address"
  - "supplier.s_phone"
  - "supplier.s_comment"
  - "nation.n_name"
Shared Hit Blocks: 5715
Shared Read Blocks: 1390
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 1923.97
    Total Cost: 1946.40
    Plan Rows: 1
    Plan Width: 152
    Actual Startup Time: 320.392
    Actual Total Time: 332.084
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "part.p_partkey"
      - "part.p_mfgr"
      - "supplier.s_acctbal"
      - "supplier.s_name"
```

```
      - "supplier.s_address"
      - "supplier.s_phone"
      - "supplier.s_comment"
      - "supplier.s_nationkey"
Shared Hit Blocks: 4795
Shared Read Blocks: 1390
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 1923.68
    Total Cost: 1946.08
    Plan Rows: 1
    Plan Width: 23
    Actual Startup Time: 319.987
    Actual Total Time: 323.775
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "part.p_partkey"
      - "part.p_mfgr"
      - "partsupp.ps_suppkey"
    Join Filter: "(minperpart.mpp_mincost = partsupp.ps_supplycost)"
    Rows Removed by Join Filter: 1380
    Shared Hit Blocks: 3441
    Shared Read Blocks: 1364
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
```

```
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 1923.26
    Total Cost: 1937.86
    Plan Rows: 2
    Plan Width: 55
    Actual Startup Time: 319.968
    Actual Total Time: 321.123
    Actual Rows: 460
    Actual Loops: 1
    Output:
      - "part.p_partkey"
      - "part.p_mfgr"
      - "minperpart.mpp_mincost"
      - "minperpart.mpp_partkey"
    Hash Cond: "(minperpart.mpp_partkey = part.p_partkey)"
    Shared Hit Blocks: 2054
    Shared Read Blocks: 1364
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "CTE Scan"
        Parent Relationship: "Outer"
        CTE Name: "minperpart"
        Alias: "minperpart"
        Startup Cost: 0.00
        Total Cost: 12.28
        Plan Rows: 614
        Plan Width: 36
        Actual Startup Time: 318.650
        Actual Total Time: 319.487
        Actual Rows: 460
        Actual Loops: 1
        Output:
```

```
            - "minperpart.mpp_mincost"
            - "minperpart.mpp_partkey"
         Shared Hit Blocks: 1579
         Shared Read Blocks: 1364
         Shared Dirtied Blocks: 0
         Shared Written Blocks: 0
         Local Hit Blocks: 0
         Local Read Blocks: 0
         Local Dirtied Blocks: 0
         Local Written Blocks: 0
         Temp Read Blocks: 0
         Temp Written Blocks: 0
         I/O Read Time: 0.000
         I/O Write Time: 0.000
       - Node Type: "Hash"
         Parent Relationship: "Inner"
         Startup Cost: 1913.64
         Total Cost: 1913.64
         Plan Rows: 769
         Plan Width: 19
         Actual Startup Time: 1.298
         Actual Total Time: 1.298
         Actual Rows: 747
         Actual Loops: 1
         Output:
            - "part.p_partkey"
            - "part.p_mfgr"
         Hash Buckets: 1024
         Hash Batches: 1
         Original Hash Batches: 1
         Peak Memory Usage: 38
         Shared Hit Blocks: 475
         Shared Read Blocks: 0
         Shared Dirtied Blocks: 0
         Shared Written Blocks: 0
         Local Hit Blocks: 0
         Local Read Blocks: 0
         Local Dirtied Blocks: 0
         Local Written Blocks: 0
         Temp Read Blocks: 0
         Temp Written Blocks: 0
         I/O Read Time: 0.000
         I/O Write Time: 0.000
         Plans:
            - Node Type: "Bitmap Heap Scan"
```

```
Parent Relationship: "Outer"
Relation Name: "part"
Schema: "public"
Alias: "part"
Startup Cost: 30.13
Total Cost: 1913.64
Plan Rows: 769
Plan Width: 19
Actual Startup Time: 0.197
Actual Total Time: 1.063
Actual Rows: 747
Actual Loops: 1
Output:
  - "part.p_partkey"
  - "part.p_mfgr"
Recheck Cond: "(part.p_size = 15)"
Rows Removed by Index Recheck: 0
Filter: "(reverse(part.p_type) ~~ 'SSARB%'::text)"
Rows Removed by Filter: 0
Exact Heap Blocks: 468
Lossy Heap Blocks: 0
Shared Hit Blocks: 475
Shared Read Blocks: 0
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Bitmap Index Scan"
    Parent Relationship: "Outer"
    Index Name: "idx_q11_p_size_reverse_type"
    Startup Cost: 0.00
    Total Cost: 29.94
    Plan Rows: 761
    Plan Width: 0
    Actual Startup Time: 0.132
    Actual Total Time: 0.132
    Actual Rows: 747
    Actual Loops: 1
```

```
                    Index Cond: "((part.p_size = 15) AND (reverse(part.p
                    Shared Hit Blocks: 7
                    Shared Read Blocks: 0
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
  - Node Type: "Index Only Scan"
    Parent Relationship: "Inner"
    Scan Direction: "Forward"
    Index Name: "idx_q11_partsupp"
    Relation Name: "partsupp"
    Schema: "public"
    Alias: "partsupp"
    Startup Cost: 0.42
    Total Cost: 4.06
    Plan Rows: 4
    Plan Width: 14
    Actual Startup Time: 0.003
    Actual Total Time: 0.004
    Actual Rows: 4
    Actual Loops: 460
    Output:
      - "partsupp.ps_partkey"
      - "partsupp.ps_suppkey"
      - "partsupp.ps_supplycost"
    Index Cond: "(partsupp.ps_partkey = part.p_partkey)"
    Rows Removed by Index Recheck: 0
    Heap Fetches: 0
    Shared Hit Blocks: 1387
    Shared Read Blocks: 0
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
```

```
                I/O Read Time: 0.000
                I/O Write Time: 0.000
          - Node Type: "Index Scan"
            Parent Relationship: "Inner"
            Scan Direction: "Forward"
            Index Name: "supplier_pkey"
            Relation Name: "supplier"
            Schema: "public"
            Alias: "supplier"
            Startup Cost: 0.29
            Total Cost: 0.31
            Plan Rows: 1
            Plan Width: 137
            Actual Startup Time: 0.017
            Actual Total Time: 0.017
            Actual Rows: 1
            Actual Loops: 460
            Output:
              - "supplier.s_suppkey"
              - "supplier.s_name"
              - "supplier.s_address"
              - "supplier.s_nationkey"
              - "supplier.s_phone"
              - "supplier.s_acctbal"
              - "supplier.s_comment"
            Index Cond: "(supplier.s_suppkey = partsupp.ps_suppkey)"
            Rows Removed by Index Recheck: 0
            Shared Hit Blocks: 1354
            Shared Read Blocks: 26
            Shared Dirtied Blocks: 0
            Shared Written Blocks: 0
            Local Hit Blocks: 0
            Local Read Blocks: 0
            Local Dirtied Blocks: 0
            Local Written Blocks: 0
            Temp Read Blocks: 0
            Temp Written Blocks: 0
            I/O Read Time: 0.000
            I/O Write Time: 0.000
      - Node Type: "Index Scan"
        Parent Relationship: "Inner"
        Scan Direction: "Forward"
        Index Name: "nation_pkey"
        Relation Name: "nation"
        Schema: "public"
```

```
              Alias: "nation"
              Startup Cost: 0.14
              Total Cost: 0.16
              Plan Rows: 1
              Plan Width: 12
              Actual Startup Time: 0.001
              Actual Total Time: 0.001
              Actual Rows: 1
              Actual Loops: 460
              Output:
                - "nation.n_nationkey"
                - "nation.n_name"
                - "nation.n_regionkey"
                - "nation.n_comment"
              Index Cond: "(nation.n_nationkey = supplier.s_nationkey)"
              Rows Removed by Index Recheck: 0
              Shared Hit Blocks: 920
              Shared Read Blocks: 0
              Shared Dirtied Blocks: 0
              Shared Written Blocks: 0
              Local Hit Blocks: 0
              Local Read Blocks: 0
              Local Dirtied Blocks: 0
              Local Written Blocks: 0
              Temp Read Blocks: 0
              Temp Written Blocks: 0
              I/O Read Time: 0.000
              I/O Write Time: 0.000
        - Node Type: "Seq Scan"
          Parent Relationship: "Inner"
          Relation Name: "region"
          Schema: "public"
          Alias: "region"
          Startup Cost: 0.00
          Total Cost: 1.06
          Plan Rows: 1
          Plan Width: 0
          Actual Startup Time: 0.001
          Actual Total Time: 0.001
          Actual Rows: 1
          Actual Loops: 460
          Output:
            - "region.r_regionkey"
            - "region.r_name"
            - "region.r_comment"
```

```
                    Filter: "(region.r_name = 'EUROPE'::text)"
                    Rows Removed by Filter: 4
                    Shared Hit Blocks: 460
                    Shared Read Blocks: 0
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
  Triggers:
  Execution Time: 335.209
```

Resultados Q12

Original

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 350016.45
    Total Cost: 350796.80
    Plan Rows: 312139
    Plan Width: 24
    Actual Startup Time: 17927.911
    Actual Total Time: 17929.565
    Actual Rows: 11620
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Sort Key:
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
      - "orders.o_orderdate"
```

```
Sort Method: "quicksort"
Sort Space Used: 1292
Sort Space Type: "Memory"
Shared Hit Blocks: 502492
Shared Read Blocks: 124387
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Sorted"
    Parent Relationship: "Outer"
    Startup Cost: 305765.24
    Total Cost: 315129.41
    Plan Rows: 312139
    Plan Width: 24
    Actual Startup Time: 17883.439
    Actual Total Time: 17912.970
    Actual Rows: 11620
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount)))"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Group Key:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Shared Hit Blocks: 502484
    Shared Read Blocks: 124387
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
```

```
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Sort"
    Parent Relationship: "Outer"
    Startup Cost: 305765.24
    Total Cost: 306545.59
    Plan Rows: 312139
    Plan Width: 24
    Actual Startup Time: 17882.787
    Actual Total Time: 17886.887
    Actual Rows: 30519
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
    Sort Key:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Sort Method: "quicksort"
    Sort Space Used: 3153
    Sort Space Type: "Memory"
    Shared Hit Blocks: 502484
    Shared Read Blocks: 124387
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Nested Loop"
        Parent Relationship: "Outer"
        Join Type: "Inner"
        Startup Cost: 5817.81
        Total Cost: 270878.20
```

```
Plan Rows: 312139
Plan Width: 24
Actual Startup Time: 244.764
Actual Total Time: 17859.258
Actual Rows: 30519
Actual Loops: 1
Output:
  - "lineitem.l_orderkey"
  - "orders.o_orderdate"
  - "orders.o_shippriority"
  - "lineitem.l_extendedprice"
  - "lineitem.l_discount"
Shared Hit Blocks: 502481
Shared Read Blocks: 124387
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 5817.38
    Total Cost: 59389.35
    Plan Rows: 145750
    Plan Width: 12
    Actual Startup Time: 243.688
    Actual Total Time: 1267.156
    Actual Rows: 147126
    Actual Loops: 1
    Output:
      - "orders.o_orderdate"
      - "orders.o_shippriority"
      - "orders.o_orderkey"
    Hash Cond: "(orders.o_custkey = customer.c_custkey)"
    Shared Hit Blocks: 3
    Shared Read Blocks: 28759
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
```

```
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "orders"
    Schema: "public"
    Alias: "orders"
    Startup Cost: 0.00
    Total Cost: 43946.00
    Plan Rows: 726087
    Plan Width: 16
    Actual Startup Time: 0.006
    Actual Total Time: 397.134
    Actual Rows: 727305
    Actual Loops: 1
    Output:
      - "orders.o_orderkey"
      - "orders.o_custkey"
      - "orders.o_orderstatus"
      - "orders.o_totalprice"
      - "orders.o_orderdate"
      - "orders.o_orderpriority"
      - "orders.o_clerk"
      - "orders.o_shippriority"
      - "orders.o_comment"
    Filter: "(orders.o_orderdate < '1995-03-15'::date)"
    Rows Removed by Filter: 772695
    Shared Hit Blocks: 1
    Shared Read Blocks: 25195
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
```

```
  I/O Write Time: 0.000
- Node Type: "Hash"
  Parent Relationship: "Inner"
  Startup Cost: 5441.00
  Total Cost: 5441.00
  Plan Rows: 30110
  Plan Width: 4
  Actual Startup Time: 243.646
  Actual Total Time: 243.646
  Actual Rows: 30142
  Actual Loops: 1
  Output:
    - "customer.c_custkey"
  Hash Buckets: 4096
  Hash Batches: 1
  Original Hash Batches: 1
  Peak Memory Usage: 1060
  Shared Hit Blocks: 2
  Shared Read Blocks: 3564
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 0
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Seq Scan"
      Parent Relationship: "Outer"
      Relation Name: "customer"
      Schema: "public"
      Alias: "customer"
      Startup Cost: 0.00
      Total Cost: 5441.00
      Plan Rows: 30110
      Plan Width: 4
      Actual Startup Time: 0.003
      Actual Total Time: 234.851
      Actual Rows: 30142
      Actual Loops: 1
      Output:
        - "customer.c_custkey"
```

```
                    Filter: "(customer.c_mktsegment = 'BUILDING'::text)"
                    Rows Removed by Filter: 119858
                    Shared Hit Blocks: 2
                    Shared Read Blocks: 3564
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
          - Node Type: "Index Scan"
            Parent Relationship: "Inner"
            Scan Direction: "Forward"
            Index Name: "lineitem_pkey"
            Relation Name: "lineitem"
            Schema: "public"
            Alias: "lineitem"
            Startup Cost: 0.43
            Total Cost: 1.38
            Plan Rows: 7
            Plan Width: 16
            Actual Startup Time: 0.112
            Actual Total Time: 0.112
            Actual Rows: 0
            Actual Loops: 147126
            Output:
              - "lineitem.l_orderkey"
              - "lineitem.l_partkey"
              - "lineitem.l_suppkey"
              - "lineitem.l_linenumber"
              - "lineitem.l_quantity"
              - "lineitem.l_extendedprice"
              - "lineitem.l_discount"
              - "lineitem.l_tax"
              - "lineitem.l_returnflag"
              - "lineitem.l_linestatus"
              - "lineitem.l_shipdate"
              - "lineitem.l_commitdate"
              - "lineitem.l_receiptdate"
              - "lineitem.l_shipinstruct"
              - "lineitem.l_shipmode"
```

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```
                                  - "lineitem.l_comment"
                        Index Cond: "(lineitem.l_orderkey = orders.o_orderkey)"
                        Rows Removed by Index Recheck: 0
                        Filter: "(lineitem.l_shipdate > '1995-03-15'::date)"
                        Rows Removed by Filter: 4
                        Shared Hit Blocks: 502478
                        Shared Read Blocks: 95628
                        Shared Dirtied Blocks: 0
                        Shared Written Blocks: 0
                        Local Hit Blocks: 0
                        Local Read Blocks: 0
                        Local Dirtied Blocks: 0
                        Local Written Blocks: 0
                        Temp Read Blocks: 0
                        Temp Written Blocks: 0
                        I/O Read Time: 0.000
                        I/O Write Time: 0.000
    Triggers:
    Execution Time: 17932.438
```

Mejorado

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 298351.41
    Total Cost: 299143.33
    Plan Rows: 316767
    Plan Width: 24
    Actual Startup Time: 2982.333
    Actual Total Time: 2983.901
    Actual Rows: 11620
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Sort Key:
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
      - "orders.o_orderdate"
```

```
Sort Method: "quicksort"
Sort Space Used: 1292
Sort Space Type: "Memory"
Shared Hit Blocks: 88068
Shared Read Blocks: 21854
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 7701
Temp Written Blocks: 7699
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Sorted"
    Parent Relationship: "Outer"
    Startup Cost: 253407.39
    Total Cost: 262910.40
    Plan Rows: 316767
    Plan Width: 24
    Actual Startup Time: 2937.583
    Actual Total Time: 2967.587
    Actual Rows: 11620
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount)))"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Group Key:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Shared Hit Blocks: 88060
    Shared Read Blocks: 21854
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 7701
```

```
Temp Written Blocks: 7699
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Sort"
    Parent Relationship: "Outer"
    Startup Cost: 253407.39
    Total Cost: 254199.30
    Plan Rows: 316767
    Plan Width: 24
    Actual Startup Time: 2937.554
    Actual Total Time: 2942.177
    Actual Rows: 30519
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
    Sort Key:
      - "lineitem.l_orderkey"
      - "orders.o_orderdate"
      - "orders.o_shippriority"
    Sort Method: "quicksort"
    Sort Space Used: 3153
    Sort Space Type: "Memory"
    Shared Hit Blocks: 88060
    Shared Read Blocks: 21854
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 7701
    Temp Written Blocks: 7699
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Hash Join"
        Parent Relationship: "Outer"
        Join Type: "Inner"
        Startup Cost: 48310.15
        Total Cost: 217966.37
```

```
Plan Rows: 316767
Plan Width: 24
Actual Startup Time: 459.309
Actual Total Time: 2921.608
Actual Rows: 30519
Actual Loops: 1
Output:
  - "lineitem.l_orderkey"
  - "orders.o_orderdate"
  - "orders.o_shippriority"
  - "lineitem.l_extendedprice"
  - "lineitem.l_discount"
Hash Cond: "(lineitem.l_orderkey = orders.o_orderkey)"
Shared Hit Blocks: 88057
Shared Read Blocks: 21854
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 7701
Temp Written Blocks: 7699
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Index Only Scan"
    Parent Relationship: "Outer"
    Scan Direction: "Forward"
    Index Name: "q12_lineitem_idx"
    Relation Name: "lineitem"
    Schema: "public"
    Alias: "lineitem"
    Startup Cost: 0.56
    Total Cost: 121713.48
    Plan Rows: 3260167
    Plan Width: 16
    Actual Startup Time: 4.010
    Actual Total Time: 991.062
    Actual Rows: 3241776
    Actual Loops: 1
    Output:
      - "lineitem.l_orderkey"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
```

Index Cond: "(lineitem.l_shipdate > '1995-03-15'::date)"
Rows Removed by Index Recheck: 0
Heap Fetches: 0
Shared Hit Blocks: 2712
Shared Read Blocks: 15975
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Hash"
  Parent Relationship: "Inner"
  Startup Cost: 45775.80
  Total Cost: 45775.80
  Plan Rows: 145744
  Plan Width: 12
  Actual Startup Time: 455.148
  Actual Total Time: 455.148
  Actual Rows: 147126
  Actual Loops: 1
  Output:
    - "orders.o_orderdate"
    - "orders.o_shippriority"
    - "orders.o_orderkey"
  Hash Buckets: 16384
  Hash Batches: 2
  Original Hash Batches: 2
  Peak Memory Usage: 3167
  Shared Hit Blocks: 85345
  Shared Read Blocks: 5879
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 286
  I/O Read Time: 0.000
  I/O Write Time: 0.000

```
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 0.85
    Total Cost: 45775.80
    Plan Rows: 145744
    Plan Width: 12
    Actual Startup Time: 3.789
    Actual Total Time: 408.440
    Actual Rows: 147126
    Actual Loops: 1
    Output:
      - "orders.o_orderdate"
      - "orders.o_shippriority"
      - "orders.o_orderkey"
    Shared Hit Blocks: 85345
    Shared Read Blocks: 5879
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Index Only Scan"
        Parent Relationship: "Outer"
        Scan Direction: "Forward"
        Index Name: "q12_customer_idx"
        Relation Name: "customer"
        Schema: "public"
        Alias: "customer"
        Startup Cost: 0.42
        Total Cost: 995.00
        Plan Rows: 30090
        Plan Width: 4
        Actual Startup Time: 2.114
        Actual Total Time: 11.595
        Actual Rows: 30142
        Actual Loops: 1
        Output:
```

```
  - "customer.c_mktsegment"
  - "customer.c_custkey"
Index Cond: "(customer.c_mktsegment = 'BUILDING'::text)"
Rows Removed by Index Recheck: 0
Heap Fetches: 0
Shared Hit Blocks: 0
Shared Read Blocks: 120
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Index Only Scan"
  Parent Relationship: "Inner"
  Scan Direction: "Forward"
  Index Name: "q12_orders_idx"
  Relation Name: "orders"
  Schema: "public"
  Alias: "orders"
  Startup Cost: 0.43
  Total Cost: 1.40
  Plan Rows: 9
  Plan Width: 16
  Actual Startup Time: 0.010
  Actual Total Time: 0.011
  Actual Rows: 5
  Actual Loops: 30142
  Output:
    - "orders.o_custkey"
    - "orders.o_orderdate"
    - "orders.o_orderkey"
    - "orders.o_shippriority"
  Index Cond: "((orders.o_custkey = customer.c_custkey) AND (o
  Rows Removed by Index Recheck: 0
  Heap Fetches: 0
  Shared Hit Blocks: 85345
  Shared Read Blocks: 5759
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
```

```
                                        Local Read Blocks: 0
                                        Local Dirtied Blocks: 0
                                        Local Written Blocks: 0
                                        Temp Read Blocks: 0
                                        Temp Written Blocks: 0
                                        I/O Read Time: 0.000
                                        I/O Write Time: 0.000
       Triggers:
       Execution Time: 2985.627
```

Resultados Q13

Original

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 277064.48
    Total Cost: 277207.46
    Plan Rows: 57193
    Plan Width: 188
    Actual Startup Time: 17779.329
    Actual Total Time: 17792.494
    Actual Rows: 37967
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
      - "customer.c_acctbal"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
    Sort Key:
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
    Sort Method: "external merge"
    Sort Space Used: 6392
    Sort Space Type: "Disk"
    Shared Hit Blocks: 19
```

```
Shared Read Blocks: 127301
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 6496
Temp Written Blocks: 6482
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Sorted"
    Parent Relationship: "Outer"
    Startup Cost: 264976.00
    Total Cost: 267263.72
    Plan Rows: 57193
    Plan Width: 188
    Actual Startup Time: 17387.902
    Actual Total Time: 17676.107
    Actual Rows: 37967
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount)))"
      - "customer.c_acctbal"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
    Group Key:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_phone"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_comment"
    Shared Hit Blocks: 14
    Shared Read Blocks: 127301
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
```

```
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 5695
Temp Written Blocks: 5681
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Sort"
    Parent Relationship: "Outer"
    Startup Cost: 264976.00
    Total Cost: 265118.98
    Plan Rows: 57193
    Plan Width: 188
    Actual Startup Time: 17387.107
    Actual Total Time: 17542.542
    Actual Rows: 114705
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
    Sort Key:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_phone"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_comment"
    Sort Method: "external merge"
    Sort Space Used: 19816
    Sort Space Type: "Disk"
    Shared Hit Blocks: 14
    Shared Read Blocks: 127301
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
```

```
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 5695
Temp Written Blocks: 5681
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 58606.39
    Total Cost: 255175.24
    Plan Rows: 57193
    Plan Width: 188
    Actual Startup Time: 2817.310
    Actual Total Time: 15793.421
    Actual Rows: 114705
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "nation.n_name"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
    Hash Cond: "(customer.c_nationkey = nation.n_nationkey)"
    Shared Hit Blocks: 6
    Shared Read Blocks: 127301
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 3213
    Temp Written Blocks: 3199
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Hash Join"
        Parent Relationship: "Outer"
        Join Type: "Inner"
```

Startup Cost: 58578.39
Total Cost: 254360.83
Plan Rows: 57193
Plan Width: 160
Actual Startup Time: 2816.977
Actual Total Time: 15741.991
Actual Rows: 114705
Actual Loops: 1
Output:
  - "customer.c_custkey"
  - "customer.c_name"
  - "customer.c_acctbal"
  - "customer.c_address"
  - "customer.c_phone"
  - "customer.c_comment"
  - "customer.c_nationkey"
  - "lineitem.l_extendedprice"
  - "lineitem.l_discount"
Hash Cond: "(orders.o_custkey = customer.c_custkey)"
Shared Hit Blocks: 6
Shared Read Blocks: 127300
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 3213
Temp Written Blocks: 3199
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 48414.39
    Total Cost: 239341.46
    Plan Rows: 57193
    Plan Width: 16
    Actual Startup Time: 2647.620
    Actual Total Time: 15407.533
    Actual Rows: 114705
    Actual Loops: 1
    Output:
      - "orders.o_custkey"

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```
          - "lineitem.l_extendedprice"
          - "lineitem.l_discount"
        Hash Cond: "(lineitem.l_orderkey = orders.o_orderkey)"
        Shared Hit Blocks: 4
        Shared Read Blocks: 123736
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
        Plans:
          - Node Type: "Seq Scan"
            Parent Relationship: "Outer"
            Relation Name: "lineitem"
            Schema: "public"
            Alias: "lineitem"
            Startup Cost: 0.00
            Total Cost: 173561.69
            Plan Rows: 1492752
            Plan Width: 16
            Actual Startup Time: 0.011
            Actual Total Time: 12032.813
            Actual Rows: 1478870
            Actual Loops: 1
            Output:
              - "lineitem.l_orderkey"
              - "lineitem.l_partkey"
              - "lineitem.l_suppkey"
              - "lineitem.l_linenumber"
              - "lineitem.l_quantity"
              - "lineitem.l_extendedprice"
              - "lineitem.l_discount"
              - "lineitem.l_tax"
              - "lineitem.l_returnflag"
              - "lineitem.l_linestatus"
              - "lineitem.l_shipdate"
              - "lineitem.l_commitdate"
              - "lineitem.l_receiptdate"
              - "lineitem.l_shipinstruct"
              - "lineitem.l_shipmode"
```

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```
            - "lineitem.l_comment"
        Filter: "(lineitem.l_returnflag = 'R'::text)"
        Rows Removed by Filter: 4522345
        Shared Hit Blocks: 2
        Shared Read Blocks: 98542
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
    - Node Type: "Hash"
      Parent Relationship: "Inner"
      Startup Cost: 47696.00
      Total Cost: 47696.00
      Plan Rows: 57471
      Plan Width: 8
      Actual Startup Time: 2647.552
      Actual Total Time: 2647.552
      Actual Rows: 57069
      Actual Loops: 1
      Output:
        - "orders.o_custkey"
        - "orders.o_orderkey"
      Hash Buckets: 8192
      Hash Batches: 1
      Original Hash Batches: 1
      Peak Memory Usage: 2230
      Shared Hit Blocks: 2
      Shared Read Blocks: 25194
      Shared Dirtied Blocks: 0
      Shared Written Blocks: 0
      Local Hit Blocks: 0
      Local Read Blocks: 0
      Local Dirtied Blocks: 0
      Local Written Blocks: 0
      Temp Read Blocks: 0
      Temp Written Blocks: 0
      I/O Read Time: 0.000
      I/O Write Time: 0.000
      Plans:
```

```
            - Node Type: "Seq Scan"
              Parent Relationship: "Outer"
              Relation Name: "orders"
              Schema: "public"
              Alias: "orders"
              Startup Cost: 0.00
              Total Cost: 47696.00
              Plan Rows: 57471
              Plan Width: 8
              Actual Startup Time: 0.008
              Actual Total Time: 2623.881
              Actual Rows: 57069
              Actual Loops: 1
              Output:
                - "orders.o_custkey"
                - "orders.o_orderkey"
              Filter: "((orders.o_orderdate >= '1993-10-01'::date) AND
              Rows Removed by Filter: 1442931
              Shared Hit Blocks: 2
              Shared Read Blocks: 25194
              Shared Dirtied Blocks: 0
              Shared Written Blocks: 0
              Local Hit Blocks: 0
              Local Read Blocks: 0
              Local Dirtied Blocks: 0
              Local Written Blocks: 0
              Temp Read Blocks: 0
              Temp Written Blocks: 0
              I/O Read Time: 0.000
              I/O Write Time: 0.000
        - Node Type: "Hash"
          Parent Relationship: "Inner"
          Startup Cost: 5066.00
          Total Cost: 5066.00
          Plan Rows: 150000
          Plan Width: 148
          Actual Startup Time: 166.747
          Actual Total Time: 166.747
          Actual Rows: 150000
          Actual Loops: 1
          Output:
            - "customer.c_custkey"
            - "customer.c_name"
            - "customer.c_acctbal"
            - "customer.c_address"
```

```
    - "customer.c_phone"
    - "customer.c_comment"
    - "customer.c_nationkey"
Hash Buckets: 4096
Hash Batches: 8
Original Hash Batches: 8
Peak Memory Usage: 3398
Shared Hit Blocks: 2
Shared Read Blocks: 3564
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 2733
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "customer"
    Schema: "public"
    Alias: "customer"
    Startup Cost: 0.00
    Total Cost: 5066.00
    Plan Rows: 150000
    Plan Width: 148
    Actual Startup Time: 0.002
    Actual Total Time: 85.448
    Actual Rows: 150000
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
      - "customer.c_nationkey"
    Shared Hit Blocks: 2
    Shared Read Blocks: 3564
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
```

```
              Local Hit Blocks: 0
              Local Read Blocks: 0
              Local Dirtied Blocks: 0
              Local Written Blocks: 0
              Temp Read Blocks: 0
              Temp Written Blocks: 0
              I/O Read Time: 0.000
              I/O Write Time: 0.000
  - Node Type: "Hash"
    Parent Relationship: "Inner"
    Startup Cost: 18.00
    Total Cost: 18.00
    Plan Rows: 800
    Plan Width: 36
    Actual Startup Time: 0.320
    Actual Total Time: 0.320
    Actual Rows: 25
    Actual Loops: 1
    Output:
      - "nation.n_name"
      - "nation.n_nationkey"
    Hash Buckets: 1024
    Hash Batches: 1
    Original Hash Batches: 1
    Peak Memory Usage: 2
    Shared Hit Blocks: 0
    Shared Read Blocks: 1
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Seq Scan"
        Parent Relationship: "Outer"
        Relation Name: "nation"
        Schema: "public"
        Alias: "nation"
        Startup Cost: 0.00
        Total Cost: 18.00
```

```
                          Plan Rows: 800
                          Plan Width: 36
                          Actual Startup Time: 0.305
                          Actual Total Time: 0.308
                          Actual Rows: 25
                          Actual Loops: 1
                          Output:
                            - "nation.n_name"
                            - "nation.n_nationkey"
                          Shared Hit Blocks: 0
                          Shared Read Blocks: 1
                          Shared Dirtied Blocks: 0
                          Shared Written Blocks: 0
                          Local Hit Blocks: 0
                          Local Read Blocks: 0
                          Local Dirtied Blocks: 0
                          Local Written Blocks: 0
                          Temp Read Blocks: 0
                          Temp Written Blocks: 0
                          I/O Read Time: 0.000
                          I/O Write Time: 0.000
    Triggers:
    Execution Time: 17802.451
```

Mejorado

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 81251.02
    Total Cost: 81395.25
    Plan Rows: 57693
    Plan Width: 164
    Actual Startup Time: 1505.343
    Actual Total Time: 1512.375
    Actual Rows: 37967
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
```

```
    - "customer.c_acctbal"
    - "nation.n_name"
    - "customer.c_address"
    - "customer.c_phone"
    - "customer.c_comment"
Sort Key:
    - "(sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount))))"
Sort Method: "quicksort"
Sort Space Used: 11535
Sort Space Type: "Memory"
Shared Hit Blocks: 8
Shared Read Blocks: 11078
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
    - Node Type: "Aggregate"
      Strategy: "Hashed"
      Parent Relationship: "Outer"
      Startup Cost: 75967.46
      Total Cost: 76688.63
      Plan Rows: 57693
      Plan Width: 164
      Actual Startup Time: 1421.157
      Actual Total Time: 1444.275
      Actual Rows: 37967
      Actual Loops: 1
      Output:
        - "customer.c_custkey"
        - "customer.c_name"
        - "sum((lineitem.l_extendedprice * (1::numeric - lineitem.l_discount)))"
        - "customer.c_acctbal"
        - "nation.n_name"
        - "customer.c_address"
        - "customer.c_phone"
        - "customer.c_comment"
      Group Key:
        - "customer.c_custkey"
```

- "customer.c_name"
         - "customer.c_acctbal"
         - "customer.c_phone"
         - "nation.n_name"
         - "customer.c_address"
         - "customer.c_comment"
Shared Hit Blocks: 3
Shared Read Blocks: 11078
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 13805.55
    Total Cost: 74525.14
    Plan Rows: 57693
    Plan Width: 164
    Actual Startup Time: 267.874
    Actual Total Time: 1216.388
    Actual Rows: 114705
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
      - "nation.n_name"
    Hash Cond: "(customer.c_nationkey = nation.n_nationkey)"
    Shared Hit Blocks: 3
    Shared Read Blocks: 11078
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0

```
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 13803.99
    Total Cost: 73730.30
    Plan Rows: 57693
    Plan Width: 160
    Actual Startup Time: 267.847
    Actual Total Time: 1164.649
    Actual Rows: 114705
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_address"
      - "customer.c_phone"
      - "customer.c_comment"
      - "customer.c_nationkey"
      - "lineitem.l_extendedprice"
      - "lineitem.l_discount"
    Hash Cond: "(orders.o_custkey = customer.c_custkey)"
    Shared Hit Blocks: 2
    Shared Read Blocks: 11078
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Merge Join"
```

```
Parent Relationship: "Outer"
Join Type: "Inner"
Startup Cost: 6862.99
Total Cost: 65419.09
Plan Rows: 57693
Plan Width: 16
Actual Startup Time: 39.514
Actual Total Time: 816.179
Actual Rows: 114705
Actual Loops: 1
Output:
  - "orders.o_custkey"
  - "lineitem.l_extendedprice"
  - "lineitem.l_discount"
Merge Cond: "(orders.o_orderkey = lineitem.l_orderkey)"
Shared Hit Blocks: 0
Shared Read Blocks: 7514
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Sort"
    Parent Relationship: "Outer"
    Startup Cost: 6860.76
    Total Cost: 7010.16
    Plan Rows: 59761
    Plan Width: 8
    Actual Startup Time: 37.498
    Actual Total Time: 50.686
    Actual Rows: 57069
    Actual Loops: 1
    Output:
      - "orders.o_custkey"
      - "orders.o_orderkey"
    Sort Key:
      - "orders.o_orderkey"
    Sort Method: "quicksort"
    Sort Space Used: 4212
```

```
Sort Space Type: "Memory"
Shared Hit Blocks: 0
Shared Read Blocks: 223
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Index Only Scan"
    Parent Relationship: "Outer"
    Scan Direction: "Forward"
    Index Name: "q13_orders_idx"
    Relation Name: "orders"
    Schema: "public"
    Alias: "orders"
    Startup Cost: 0.43
    Total Cost: 2119.65
    Plan Rows: 59761
    Plan Width: 8
    Actual Startup Time: 1.448
    Actual Total Time: 17.370
    Actual Rows: 57069
    Actual Loops: 1
    Output:
      - "orders.o_custkey"
      - "orders.o_orderkey"
    Index Cond: "((orders.o_orderdate >= '1993-10-01'::date) AND
    Rows Removed by Index Recheck: 0
    Heap Fetches: 0
    Shared Hit Blocks: 0
    Shared Read Blocks: 223
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
```

```
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
            - Node Type: "Index Only Scan"
              Parent Relationship: "Inner"
              Scan Direction: "Forward"
              Index Name: "q13_lineitem_idx"
              Relation Name: "lineitem"
              Schema: "public"
              Alias: "lineitem"
              Startup Cost: 0.56
              Total Cost: 54062.36
              Plan Rows: 1448103
              Plan Width: 16
              Actual Startup Time: 2.006
              Actual Total Time: 481.948
              Actual Rows: 1478866
              Actual Loops: 1
              Output:
                - "lineitem.l_returnflag"
                - "lineitem.l_orderkey"
                - "lineitem.l_extendedprice"
                - "lineitem.l_discount"
              Index Cond: "(lineitem.l_returnflag = 'R'::text)"
              Rows Removed by Index Recheck: 0
              Heap Fetches: 0
              Shared Hit Blocks: 0
              Shared Read Blocks: 7291
              Shared Dirtied Blocks: 0
              Shared Written Blocks: 0
              Local Hit Blocks: 0
              Local Read Blocks: 0
              Local Dirtied Blocks: 0
              Local Written Blocks: 0
              Temp Read Blocks: 0
              Temp Written Blocks: 0
              I/O Read Time: 0.000
              I/O Write Time: 0.000
      - Node Type: "Hash"
        Parent Relationship: "Inner"
        Startup Cost: 5066.00
        Total Cost: 5066.00
        Plan Rows: 150000
        Plan Width: 148
        Actual Startup Time: 228.267
        Actual Total Time: 228.267
```

```
Actual Rows: 150000
Actual Loops: 1
Output:
  - "customer.c_custkey"
  - "customer.c_name"
  - "customer.c_acctbal"
  - "customer.c_address"
  - "customer.c_phone"
  - "customer.c_comment"
  - "customer.c_nationkey"
Hash Buckets: 16384
Hash Batches: 1
Original Hash Batches: 1
Peak Memory Usage: 26813
Shared Hit Blocks: 2
Shared Read Blocks: 3564
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "customer"
    Schema: "public"
    Alias: "customer"
    Startup Cost: 0.00
    Total Cost: 5066.00
    Plan Rows: 150000
    Plan Width: 148
    Actual Startup Time: 0.001
    Actual Total Time: 162.862
    Actual Rows: 150000
    Actual Loops: 1
    Output:
      - "customer.c_custkey"
      - "customer.c_name"
      - "customer.c_acctbal"
      - "customer.c_address"
```

```
                          - "customer.c_phone"
                          - "customer.c_comment"
                          - "customer.c_nationkey"
                      Shared Hit Blocks: 2
                      Shared Read Blocks: 3564
                      Shared Dirtied Blocks: 0
                      Shared Written Blocks: 0
                      Local Hit Blocks: 0
                      Local Read Blocks: 0
                      Local Dirtied Blocks: 0
                      Local Written Blocks: 0
                      Temp Read Blocks: 0
                      Temp Written Blocks: 0
                      I/O Read Time: 0.000
                      I/O Write Time: 0.000
              - Node Type: "Hash"
                Parent Relationship: "Inner"
                Startup Cost: 1.25
                Total Cost: 1.25
                Plan Rows: 25
                Plan Width: 12
                Actual Startup Time: 0.017
                Actual Total Time: 0.017
                Actual Rows: 25
                Actual Loops: 1
                Output:
                  - "nation.n_name"
                  - "nation.n_nationkey"
                Hash Buckets: 1024
                Hash Batches: 1
                Original Hash Batches: 1
                Peak Memory Usage: 2
                Shared Hit Blocks: 1
                Shared Read Blocks: 0
                Shared Dirtied Blocks: 0
                Shared Written Blocks: 0
                Local Hit Blocks: 0
                Local Read Blocks: 0
                Local Dirtied Blocks: 0
                Local Written Blocks: 0
                Temp Read Blocks: 0
                Temp Written Blocks: 0
                I/O Read Time: 0.000
                I/O Write Time: 0.000
                Plans:
```

```yaml
                    - Node Type: "Seq Scan"
                      Parent Relationship: "Outer"
                      Relation Name: "nation"
                      Schema: "public"
                      Alias: "nation"
                      Startup Cost: 0.00
                      Total Cost: 1.25
                      Plan Rows: 25
                      Plan Width: 12
                      Actual Startup Time: 0.003
                      Actual Total Time: 0.007
                      Actual Rows: 25
                      Actual Loops: 1
                      Output:
                        - "nation.n_name"
                        - "nation.n_nationkey"
                      Shared Hit Blocks: 1
                      Shared Read Blocks: 0
                      Shared Dirtied Blocks: 0
                      Shared Written Blocks: 0
                      Local Hit Blocks: 0
                      Local Read Blocks: 0
                      Local Dirtied Blocks: 0
                      Local Written Blocks: 0
                      Temp Read Blocks: 0
                      Temp Written Blocks: 0
                      I/O Read Time: 0.000
                      I/O Write Time: 0.000
  Triggers:
  Execution Time: 1519.566
```

Resultados Q21

Original

Text

Yaml

```yaml
- Plan:
    Node Type: "Sort"
    Startup Cost: 304526.25
    Total Cost: 304526.25
```

```
Plan Rows: 1
Plan Width: 14
Actual Startup Time: 15856.784
Actual Total Time: 15856.784
Actual Rows: 2
Actual Loops: 1
Output:
  - "lineitem.l_shipmode"
  - "(sum(CASE WHEN ((orders.o_orderpriority = '1-URGENT'::text) OR (orders.o_orderp
  - "(sum(CASE WHEN ((orders.o_orderpriority <> '1-URGENT'::text) AND (orders.o_orde
Sort Key:
  - "lineitem.l_shipmode"
Sort Method: "quicksort"
Sort Space Used: 25
Sort Space Type: "Memory"
Shared Hit Blocks: 1945
Shared Read Blocks: 127834
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Hashed"
    Parent Relationship: "Outer"
    Startup Cost: 304526.23
    Total Cost: 304526.24
    Plan Rows: 1
    Plan Width: 14
    Actual Startup Time: 15856.738
    Actual Total Time: 15856.738
    Actual Rows: 2
    Actual Loops: 1
    Output:
      - "lineitem.l_shipmode"
      - "sum(CASE WHEN ((orders.o_orderpriority = '1-URGENT'::text) OR (orders.o_ord
      - "sum(CASE WHEN ((orders.o_orderpriority <> '1-URGENT'::text) AND (orders.o_o
    Group Key:
      - "lineitem.l_shipmode"
```

```
Shared Hit Blocks: 1940
Shared Read Blocks: 127834
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Merge Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 235689.14
    Total Cost: 304026.60
    Plan Rows: 28550
    Plan Width: 14
    Actual Startup Time: 11942.607
    Actual Total Time: 15827.573
    Actual Rows: 30988
    Actual Loops: 1
    Output:
      - "orders.o_orderpriority"
      - "lineitem.l_shipmode"
    Merge Cond: "(orders.o_orderkey = lineitem.l_orderkey)"
    Shared Hit Blocks: 1940
    Shared Read Blocks: 127834
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Index Scan"
        Parent Relationship: "Outer"
        Scan Direction: "Forward"
        Index Name: "orders_pkey"
```

```
Relation Name: "orders"
Schema: "public"
Alias: "orders"
Startup Cost: 0.43
Total Cost: 64159.66
Plan Rows: 1500000
Plan Width: 13
Actual Startup Time: 0.006
Actual Total Time: 3598.047
Actual Rows: 1499957
Actual Loops: 1
Output:
  - "orders.o_orderkey"
  - "orders.o_custkey"
  - "orders.o_orderstatus"
  - "orders.o_totalprice"
  - "orders.o_orderdate"
  - "orders.o_orderpriority"
  - "orders.o_clerk"
  - "orders.o_shippriority"
  - "orders.o_comment"
Shared Hit Blocks: 1935
Shared Read Blocks: 29292
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Sort"
Parent Relationship: "Inner"
Startup Cost: 235688.71
Total Cost: 235760.08
Plan Rows: 28550
Plan Width: 9
Actual Startup Time: 11942.541
Actual Total Time: 11948.431
Actual Rows: 30988
Actual Loops: 1
Output:
  - "lineitem.l_shipmode"
```

```
              - "lineitem.l_orderkey"
        Sort Key:
              - "lineitem.l_orderkey"
        Sort Method: "quicksort"
        Sort Space Used: 2221
        Sort Space Type: "Memory"
        Shared Hit Blocks: 5
        Shared Read Blocks: 98542
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
        Plans:
          - Node Type: "Seq Scan"
            Parent Relationship: "Outer"
            Relation Name: "lineitem"
            Schema: "public"
            Alias: "lineitem"
            Startup Cost: 0.00
            Total Cost: 233575.84
            Plan Rows: 28550
            Plan Width: 9
            Actual Startup Time: 0.685
            Actual Total Time: 11922.855
            Actual Rows: 30988
            Actual Loops: 1
            Output:
              - "lineitem.l_shipmode"
              - "lineitem.l_orderkey"
            Filter: "((lineitem.l_shipmode = ANY ('{MAIL,SHIP}'::text[])) AND (l
            Rows Removed by Filter: 5970227
            Shared Hit Blocks: 2
            Shared Read Blocks: 98542
            Shared Dirtied Blocks: 0
            Shared Written Blocks: 0
            Local Hit Blocks: 0
            Local Read Blocks: 0
            Local Dirtied Blocks: 0
            Local Written Blocks: 0
```

```
                        Temp Read Blocks: 0
                        Temp Written Blocks: 0
                        I/O Read Time: 0.000
                        I/O Write Time: 0.000
    Triggers:
    Execution Time: 15858.726
```

Mejorado

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 80589.51
    Total Cost: 80589.51
    Plan Rows: 1
    Plan Width: 14
    Actual Startup Time: 3124.558
    Actual Total Time: 3124.558
    Actual Rows: 2
    Actual Loops: 1
    Output:
      - "lineitem.l_shipmode"
      - "(count(orders.o_orderpriority) FILTER (WHERE (orders.o_orderpriority = ANY ('{1
      - "(count(orders.o_orderpriority) FILTER (WHERE (orders.o_orderpriority <> ALL ('{
    Sort Key:
      - "lineitem.l_shipmode"
    Sort Method: "quicksort"
    Sort Space Used: 25
    Sort Space Type: "Memory"
    Shared Hit Blocks: 494384
    Shared Read Blocks: 10555
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
```

```
Plans:
  - Node Type: "Aggregate"
    Strategy: "Hashed"
    Parent Relationship: "Outer"
    Startup Cost: 80589.49
    Total Cost: 80589.50
    Plan Rows: 1
    Plan Width: 14
    Actual Startup Time: 3124.509
    Actual Total Time: 3124.510
    Actual Rows: 2
    Actual Loops: 1
    Output:
      - "lineitem.l_shipmode"
      - "count(orders.o_orderpriority) FILTER (WHERE (orders.o_orderpriority = ANY (
      - "count(orders.o_orderpriority) FILTER (WHERE (orders.o_orderpriority <> ALL
    Group Key:
      - "lineitem.l_shipmode"
    Shared Hit Blocks: 494379
    Shared Read Blocks: 10555
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Nested Loop"
        Parent Relationship: "Outer"
        Join Type: "Inner"
        Startup Cost: 0.98
        Total Cost: 80235.06
        Plan Rows: 28354
        Plan Width: 14
        Actual Startup Time: 7.977
        Actual Total Time: 3098.190
        Actual Rows: 30988
        Actual Loops: 1
        Output:
          - "orders.o_orderpriority"
          - "lineitem.l_shipmode"
```

```
Shared Hit Blocks: 494379
Shared Read Blocks: 10555
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Index Only Scan"
    Parent Relationship: "Outer"
    Scan Direction: "Forward"
    Index Name: "q21_lineitem_idx"
    Relation Name: "lineitem"
    Schema: "public"
    Alias: "lineitem"
    Startup Cost: 0.56
    Total Cost: 42831.11
    Plan Rows: 28354
    Plan Width: 9
    Actual Startup Time: 4.835
    Actual Total Time: 348.068
    Actual Rows: 30988
    Actual Loops: 1
    Output:
      - "lineitem.l_receiptdate"
      - "lineitem.l_commitdate"
      - "lineitem.l_shipdate"
      - "lineitem.l_shipmode"
      - "lineitem.l_orderkey"
    Index Cond: "((lineitem.l_receiptdate >= '1994-01-01'::date) AND (lineit
    Rows Removed by Index Recheck: 0
    Filter: "((lineitem.l_shipmode = ANY ('{MAIL,SHIP}'::text[])) AND (linei
    Rows Removed by Filter: 878856
    Heap Fetches: 0
    Shared Hit Blocks: 407252
    Shared Read Blocks: 4488
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
```

```
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
                  - Node Type: "Index Only Scan"
                    Parent Relationship: "Inner"
                    Scan Direction: "Forward"
                    Index Name: "q21_orders_idx"
                    Relation Name: "orders"
                    Schema: "public"
                    Alias: "orders"
                    Startup Cost: 0.43
                    Total Cost: 1.31
                    Plan Rows: 1
                    Plan Width: 13
                    Actual Startup Time: 0.087
                    Actual Total Time: 0.088
                    Actual Rows: 1
                    Actual Loops: 30988
                    Output:
                      - "orders.o_orderkey"
                      - "orders.o_orderpriority"
                    Index Cond: "(orders.o_orderkey = lineitem.l_orderkey)"
                    Rows Removed by Index Recheck: 0
                    Heap Fetches: 0
                    Shared Hit Blocks: 87127
                    Shared Read Blocks: 6067
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
  Triggers:
  Execution Time: 3124.659
```

Resultados Q22

Original

Text

Yaml

```yaml
- Plan:
    Node Type: "Sort"
    Startup Cost: 47642.68
    Total Cost: 47650.13
    Plan Rows: 2979
    Plan Width: 38
    Actual Startup Time: 4388.303
    Actual Total Time: 4390.965
    Actual Rows: 18314
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "(count(DISTINCT partsupp.ps_suppkey))"
    Sort Key:
      - "(count(DISTINCT partsupp.ps_suppkey))"
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
    Sort Method: "quicksort"
    Sort Space Used: 2199
    Sort Space Type: "Memory"
    Shared Hit Blocks: 15
    Shared Read Blocks: 21375
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 724
    Temp Written Blocks: 724
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
```

```
- Node Type: "Aggregate"
  Strategy: "Sorted"
  Parent Relationship: "Outer"
  Startup Cost: 46696.40
  Total Cost: 47470.79
  Plan Rows: 2979
  Plan Width: 38
  Actual Startup Time: 3698.131
  Actual Total Time: 4142.493
  Actual Rows: 18314
  Actual Loops: 1
  Output:
    - "part.p_brand"
    - "part.p_type"
    - "part.p_size"
    - "count(DISTINCT partsupp.ps_suppkey)"
  Group Key:
    - "part.p_brand"
    - "part.p_type"
    - "part.p_size"
  Shared Hit Blocks: 4
  Shared Read Blocks: 21375
  Shared Dirtied Blocks: 0
  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 724
  Temp Written Blocks: 724
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Sort"
      Parent Relationship: "Outer"
      Startup Cost: 46696.40
      Total Cost: 46845.32
      Plan Rows: 59568
      Plan Width: 38
      Actual Startup Time: 3698.082
      Actual Total Time: 4069.672
      Actual Rows: 118274
      Actual Loops: 1
      Output:
        - "part.p_brand"
```

```
    - "part.p_type"
    - "part.p_size"
    - "partsupp.ps_suppkey"
Sort Key:
  - "part.p_brand"
  - "part.p_type"
  - "part.p_size"
Sort Method: "external merge"
Sort Space Used: 5776
Sort Space Type: "Disk"
Shared Hit Blocks: 4
Shared Read Blocks: 21375
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 724
Temp Written Blocks: 724
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 9425.30
    Total Cost: 41971.98
    Plan Rows: 59568
    Plan Width: 38
    Actual Startup Time: 274.745
    Actual Total Time: 1162.089
    Actual Rows: 118274
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "partsupp.ps_suppkey"
    Hash Cond: "(partsupp.ps_partkey = part.p_partkey)"
    Shared Hit Blocks: 4
    Shared Read Blocks: 21375
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
```

```
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "partsupp"
    Schema: "public"
    Alias: "partsupp"
    Startup Cost: 338.00
    Total Cost: 27789.00
    Plan Rows: 400000
    Plan Width: 8
    Actual Startup Time: 13.944
    Actual Total Time: 599.650
    Actual Rows: 799680
    Actual Loops: 1
    Output:
      - "partsupp.ps_partkey"
      - "partsupp.ps_suppkey"
      - "partsupp.ps_availqty"
      - "partsupp.ps_supplycost"
      - "partsupp.ps_comment"
    Filter: "(NOT (hashed SubPlan 1))"
    Rows Removed by Filter: 320
    Shared Hit Blocks: 2
    Shared Read Blocks: 17662
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Seq Scan"
        Parent Relationship: "SubPlan"
        Subplan Name: "SubPlan 1"
```

```
          Relation Name: "supplier"
          Schema: "public"
          Alias: "supplier"
          Startup Cost: 0.00
          Total Cost: 338.00
          Plan Rows: 1
          Plan Width: 4
          Actual Startup Time: 1.816
          Actual Total Time: 13.920
          Actual Rows: 4
          Actual Loops: 1
          Output:
            - "supplier.s_suppkey"
          Filter: "(supplier.s_comment ~~ '%Customer%Complaints%'::text)"
          Rows Removed by Filter: 9996
          Shared Hit Blocks: 0
          Shared Read Blocks: 213
          Shared Dirtied Blocks: 0
          Shared Written Blocks: 0
          Local Hit Blocks: 0
          Local Read Blocks: 0
          Local Dirtied Blocks: 0
          Local Written Blocks: 0
          Temp Read Blocks: 0
          Temp Written Blocks: 0
          I/O Read Time: 0.000
          I/O Write Time: 0.000
  - Node Type: "Hash"
    Parent Relationship: "Inner"
    Startup Cost: 8715.00
    Total Cost: 8715.00
    Plan Rows: 29784
    Plan Width: 38
    Actual Startup Time: 260.761
    Actual Total Time: 260.761
    Actual Rows: 29581
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "part.p_partkey"
    Hash Buckets: 4096
    Hash Batches: 1
    Original Hash Batches: 1
```

```
Peak Memory Usage: 2083
Shared Hit Blocks: 2
Shared Read Blocks: 3713
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "part"
    Schema: "public"
    Alias: "part"
    Startup Cost: 0.00
    Total Cost: 8715.00
    Plan Rows: 29784
    Plan Width: 38
    Actual Startup Time: 0.007
    Actual Total Time: 249.373
    Actual Rows: 29581
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "part.p_partkey"
    Filter: "((part.p_brand <> 'Brand#45'::text) AND (part.p_type !~
    Rows Removed by Filter: 170419
    Shared Hit Blocks: 2
    Shared Read Blocks: 3713
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
```

```
                                 I/O Write Time: 0.000
   Triggers:
   Execution Time: 4394.813
```

Mejorado

Text

Yaml

```
- Plan:
    Node Type: "Sort"
    Startup Cost: 47327.16
    Total Cost: 47334.41
    Plan Rows: 2900
    Plan Width: 38
    Actual Startup Time: 3666.048
    Actual Total Time: 3668.967
    Actual Rows: 18314
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "(count(DISTINCT partsupp.ps_suppkey))"
    Sort Key:
      - "(count(DISTINCT partsupp.ps_suppkey))"
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
    Sort Method: "quicksort"
    Sort Space Used: 2199
    Sort Space Type: "Memory"
    Shared Hit Blocks: 87062
    Shared Read Blocks: 6315
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 724
    Temp Written Blocks: 724
    I/O Read Time: 0.000
```

```
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Sorted"
    Parent Relationship: "Outer"
    Startup Cost: 45731.94
    Total Cost: 47160.39
    Plan Rows: 2900
    Plan Width: 38
    Actual Startup Time: 2978.621
    Actual Total Time: 3422.161
    Actual Rows: 18314
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "count(DISTINCT partsupp.ps_suppkey)"
    Group Key:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
    Shared Hit Blocks: 87051
    Shared Read Blocks: 6315
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 724
    Temp Written Blocks: 724
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Sort"
        Parent Relationship: "Outer"
        Startup Cost: 45731.94
        Total Cost: 46011.83
        Plan Rows: 111956
        Plan Width: 38
        Actual Startup Time: 2978.569
        Actual Total Time: 3351.779
        Actual Rows: 118274
        Actual Loops: 1
```

```
Output:
  - "part.p_brand"
  - "part.p_type"
  - "part.p_size"
  - "partsupp.ps_suppkey"
Sort Key:
  - "part.p_brand"
  - "part.p_type"
  - "part.p_size"
Sort Method: "external merge"
Sort Space Used: 5776
Sort Space Type: "Disk"
Shared Hit Blocks: 87051
Shared Read Blocks: 6315
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 724
Temp Written Blocks: 724
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Semi"
    Startup Cost: 1393.65
    Total Cost: 33280.49
    Plan Rows: 111956
    Plan Width: 38
    Actual Startup Time: 59.588
    Actual Total Time: 416.940
    Actual Rows: 118274
    Actual Loops: 1
    Output:
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
      - "partsupp.ps_suppkey"
    Hash Cond: "(partsupp.ps_suppkey = supplier.s_suppkey)"
    Shared Hit Blocks: 87051
    Shared Read Blocks: 6315
    Shared Dirtied Blocks: 0
```

```
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Nested Loop"
    Parent Relationship: "Outer"
    Join Type: "Inner"
    Startup Cost: 930.66
    Total Cost: 30017.38
    Plan Rows: 112281
    Plan Width: 38
    Actual Startup Time: 43.270
    Actual Total Time: 305.557
    Actual Rows: 118324
    Actual Loops: 1
    Output:
      - "partsupp.ps_suppkey"
      - "part.p_brand"
      - "part.p_type"
      - "part.p_size"
    Shared Hit Blocks: 87049
    Shared Read Blocks: 6104
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Bitmap Heap Scan"
        Parent Relationship: "Outer"
        Relation Name: "part"
        Schema: "public"
        Alias: "part"
        Startup Cost: 930.24
```

Total Cost: 5430.56
Plan Rows: 28996
Plan Width: 38
Actual Startup Time: 41.221
Actual Total Time: 126.520
Actual Rows: 29581
Actual Loops: 1
Output:
  - "part.p_partkey"
  - "part.p_name"
  - "part.p_mfgr"
  - "part.p_brand"
  - "part.p_type"
  - "part.p_size"
  - "part.p_container"
  - "part.p_retailprice"
  - "part.p_comment"
Recheck Cond: "(part.p_size = ANY ('{49,14,23,45,19,3,36,9}'::in
Rows Removed by Index Recheck: 0
Filter: "((part.p_brand <> 'Brand#45'::text) AND (part.p_type !~
Rows Removed by Filter: 2245
Exact Heap Blocks: 3712
Lossy Heap Blocks: 0
Shared Hit Blocks: 9
Shared Read Blocks: 3908
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Bitmap Index Scan"
    Parent Relationship: "Outer"
    Index Name: "idx_q11_p_size_reverse_type"
    Startup Cost: 0.00
    Total Cost: 922.99
    Plan Rows: 31413
    Plan Width: 0
    Actual Startup Time: 40.666
    Actual Total Time: 40.666

```
                    Actual Rows: 31826
                    Actual Loops: 1
                    Index Cond: "(part.p_size = ANY ('{49,14,23,45,19,3,36,9}'::
                    Shared Hit Blocks: 8
                    Shared Read Blocks: 197
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
              - Node Type: "Index Only Scan"
                Parent Relationship: "Inner"
                Scan Direction: "Forward"
                Index Name: "partsupp_pkey"
                Relation Name: "partsupp"
                Schema: "public"
                Alias: "partsupp"
                Startup Cost: 0.42
                Total Cost: 0.81
                Plan Rows: 4
                Plan Width: 8
                Actual Startup Time: 0.003
                Actual Total Time: 0.004
                Actual Rows: 4
                Actual Loops: 29581
                Output:
                  - "partsupp.ps_partkey"
                  - "partsupp.ps_suppkey"
                Index Cond: "(partsupp.ps_partkey = part.p_partkey)"
                Rows Removed by Index Recheck: 0
                Heap Fetches: 0
                Shared Hit Blocks: 87040
                Shared Read Blocks: 2196
                Shared Dirtied Blocks: 0
                Shared Written Blocks: 0
                Local Hit Blocks: 0
                Local Read Blocks: 0
                Local Dirtied Blocks: 0
                Local Written Blocks: 0
                Temp Read Blocks: 0
```

```
                  Temp Written Blocks: 0
                  I/O Read Time: 0.000
                  I/O Write Time: 0.000
      - Node Type: "Hash"
        Parent Relationship: "Inner"
        Startup Cost: 338.00
        Total Cost: 338.00
        Plan Rows: 9999
        Plan Width: 4
        Actual Startup Time: 16.298
        Actual Total Time: 16.298
        Actual Rows: 9996
        Actual Loops: 1
        Output:
          - "supplier.s_suppkey"
        Hash Buckets: 1024
        Hash Batches: 1
        Original Hash Batches: 1
        Peak Memory Usage: 352
        Shared Hit Blocks: 2
        Shared Read Blocks: 211
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
        Plans:
          - Node Type: "Seq Scan"
            Parent Relationship: "Outer"
            Relation Name: "supplier"
            Schema: "public"
            Alias: "supplier"
            Startup Cost: 0.00
            Total Cost: 338.00
            Plan Rows: 9999
            Plan Width: 4
            Actual Startup Time: 0.008
            Actual Total Time: 13.677
            Actual Rows: 9996
            Actual Loops: 1
```

```
                              Output:
                                - "supplier.s_suppkey"
                              Filter: "(supplier.s_comment !~~ '%Customer%Complaints%'::text)"
                              Rows Removed by Filter: 4
                              Shared Hit Blocks: 2
                              Shared Read Blocks: 211
                              Shared Dirtied Blocks: 0
                              Shared Written Blocks: 0
                              Local Hit Blocks: 0
                              Local Read Blocks: 0
                              Local Dirtied Blocks: 0
                              Local Written Blocks: 0
                              Temp Read Blocks: 0
                              Temp Written Blocks: 0
                              I/O Read Time: 0.000
                              I/O Write Time: 0.000
     Triggers:
     Execution Time: 3673.631
```

Resultados Q23

Original

Text

Yaml

```
- Plan:
    Node Type: "Aggregate"
    Strategy: "Sorted"
    Startup Cost: 85043.21
    Total Cost: 85061.31
    Plan Rows: 724
    Plan Width: 22
    Actual Startup Time: 3015.901
    Actual Total Time: 3018.549
    Actual Rows: 7
    Actual Loops: 1
    Output:
      - "(\"substring\"(customer.c_phone, 1, 2))"
      - "count(*)"
      - "sum(customer.c_acctbal)"
    Group Key:
```

```
      - "(\"substring\"(customer.c_phone, 1, 2))"
Shared Hit Blocks: 3576
Shared Read Blocks: 28760
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 4266
Temp Written Blocks: 4236
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Aggregate"
    Strategy: "Plain"
    Parent Relationship: "InitPlan"
    Subplan Name: "InitPlan 1 (returns $0)"
    Startup Cost: 7140.43
    Total Cost: 7140.44
    Plan Rows: 1
    Plan Width: 6
    Actual Startup Time: 266.719
    Actual Total Time: 266.719
    Actual Rows: 1
    Actual Loops: 1
    Output:
      - "avg(customer_1.c_acctbal)"
    Shared Hit Blocks: 2
    Shared Read Blocks: 3564
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Seq Scan"
        Parent Relationship: "Outer"
        Relation Name: "customer"
        Schema: "public"
```

Alias: "customer_1"
         Startup Cost: 0.00
         Total Cost: 7128.50
         Plan Rows: 4772
         Plan Width: 6
         Actual Startup Time: 0.009
         Actual Total Time: 255.627
         Actual Rows: 38120
         Actual Loops: 1
         Output:
           - "customer_1.c_custkey"
           - "customer_1.c_name"
           - "customer_1.c_address"
           - "customer_1.c_nationkey"
           - "customer_1.c_phone"
           - "customer_1.c_acctbal"
           - "customer_1.c_mktsegment"
           - "customer_1.c_comment"
         Filter: "((customer_1.c_acctbal > 0.00) AND (\"**substring**\"(customer_1.c_pho
         Rows Removed by Filter: 111880
         Shared Hit Blocks: 2
         Shared Read Blocks: 3564
         Shared Dirtied Blocks: 0
         Shared Written Blocks: 0
         Local Hit Blocks: 0
         Local Read Blocks: 0
         Local Dirtied Blocks: 0
         Local Written Blocks: 0
         Temp Read Blocks: 0
         Temp Written Blocks: 0
         I/O Read Time: 0.000
         I/O Write Time: 0.000
   - Node Type: "Sort"
     Parent Relationship: "Outer"
     Startup Cost: 77902.77
     Total Cost: 77904.58
     Plan Rows: 724
     Plan Width: 22
     Actual Startup Time: 3015.448
     Actual Total Time: 3016.298
     Actual Rows: 6384
     Actual Loops: 1
     Output:
       - "(\"**substring**\"(customer.c_phone, 1, 2))"
       - "customer.c_acctbal"

Sort Key:
  - "(\"substring\"(customer.c_phone, 1, 2))"
Sort Method: "quicksort"
Sort Space Used: 492
Sort Space Type: "Memory"
Shared Hit Blocks: 3576
Shared Read Blocks: 28760
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 4266
Temp Written Blocks: 4236
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Hash Join"
    Parent Relationship: "Outer"
    Join Type: "Anti"
    Startup Cost: 64806.00
    Total Cost: 77868.38
    Plan Rows: 724
    Plan Width: 22
    Actual Startup Time: 2823.113
    Actual Total Time: 3010.580
    Actual Rows: 6384
    Actual Loops: 1
    Output:
      - "\"substring\"(customer.c_phone, 1, 2)"
      - "customer.c_acctbal"
    Hash Cond: "(customer.c_custkey = orders.o_custkey)"
    Shared Hit Blocks: 3571
    Shared Read Blocks: 28760
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 4266
    Temp Written Blocks: 4236
    I/O Read Time: 0.000
    I/O Write Time: 0.000

```
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "customer"
    Schema: "public"
    Alias: "customer"
    Startup Cost: 0.00
    Total Cost: 7128.50
    Plan Rows: 1750
    Plan Width: 26
    Actual Startup Time: 266.742
    Actual Total Time: 331.188
    Actual Rows: 19000
    Actual Loops: 1
    Output:
      - "customer.c_phone"
      - "customer.c_acctbal"
      - "customer.c_custkey"
    Filter: "((customer.c_acctbal > $0) AND (\"substring\"(customer.c_phone
    Rows Removed by Filter: 131000
    Shared Hit Blocks: 3568
    Shared Read Blocks: 3564
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 0
    Temp Written Blocks: 0
    I/O Read Time: 0.000
    I/O Write Time: 0.000
  - Node Type: "Hash"
    Parent Relationship: "Inner"
    Startup Cost: 40196.00
    Total Cost: 40196.00
    Plan Rows: 1500000
    Plan Width: 4
    Actual Startup Time: 2556.069
    Actual Total Time: 2556.069
    Actual Rows: 1500000
    Actual Loops: 1
    Output:
      - "orders.o_custkey"
    Hash Buckets: 16384
```

```
                    Hash Batches: 16
                    Original Hash Batches: 16
                    Peak Memory Usage: 3379
                    Shared Hit Blocks: 0
                    Shared Read Blocks: 25196
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 4108
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
                    Plans:
                      - Node Type: "Seq Scan"
                        Parent Relationship: "Outer"
                        Relation Name: "orders"
                        Schema: "public"
                        Alias: "orders"
                        Startup Cost: 0.00
                        Total Cost: 40196.00
                        Plan Rows: 1500000
                        Plan Width: 4
                        Actual Startup Time: 0.706
                        Actual Total Time: 2167.669
                        Actual Rows: 1500000
                        Actual Loops: 1
                        Output:
                          - "orders.o_custkey"
                        Shared Hit Blocks: 0
                        Shared Read Blocks: 25196
                        Shared Dirtied Blocks: 0
                        Shared Written Blocks: 0
                        Local Hit Blocks: 0
                        Local Read Blocks: 0
                        Local Dirtied Blocks: 0
                        Local Written Blocks: 0
                        Temp Read Blocks: 0
                        Temp Written Blocks: 0
                        I/O Read Time: 0.000
                        I/O Write Time: 0.000
          Triggers:
          Execution Time: 3019.109
```

Mejorado

Text

Yaml

```yaml
- Plan:
    Node Type: "Aggregate"
    Strategy: "Sorted"
    Startup Cost: 85043.21
    Total Cost: 85061.31
    Plan Rows: 724
    Plan Width: 22
    Actual Startup Time: 3015.901
    Actual Total Time: 3018.549
    Actual Rows: 7
    Actual Loops: 1
    Output:
      - "(\"substring\"(customer.c_phone, 1, 2))"
      - "count(*)"
      - "sum(customer.c_acctbal)"
    Group Key:
      - "(\"substring\"(customer.c_phone, 1, 2))"
    Shared Hit Blocks: 3576
    Shared Read Blocks: 28760
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 4266
    Temp Written Blocks: 4236
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Aggregate"
        Strategy: "Plain"
        Parent Relationship: "InitPlan"
        Subplan Name: "InitPlan 1 (returns $0)"
        Startup Cost: 7140.43
        Total Cost: 7140.44
        Plan Rows: 1
        Plan Width: 6
```

```
Actual Startup Time: 266.719
Actual Total Time: 266.719
Actual Rows: 1
Actual Loops: 1
Output:
  - "avg(customer_1.c_acctbal)"
Shared Hit Blocks: 2
Shared Read Blocks: 3564
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "customer"
    Schema: "public"
    Alias: "customer_1"
    Startup Cost: 0.00
    Total Cost: 7128.50
    Plan Rows: 4772
    Plan Width: 6
    Actual Startup Time: 0.009
    Actual Total Time: 255.627
    Actual Rows: 38120
    Actual Loops: 1
    Output:
      - "customer_1.c_custkey"
      - "customer_1.c_name"
      - "customer_1.c_address"
      - "customer_1.c_nationkey"
      - "customer_1.c_phone"
      - "customer_1.c_acctbal"
      - "customer_1.c_mktsegment"
      - "customer_1.c_comment"
    Filter: "((customer_1.c_acctbal > 0.00) AND (\"substring\"(customer_1.c_phor
    Rows Removed by Filter: 111880
    Shared Hit Blocks: 2
    Shared Read Blocks: 3564
```

```
        Shared Dirtied Blocks: 0
        Shared Written Blocks: 0
        Local Hit Blocks: 0
        Local Read Blocks: 0
        Local Dirtied Blocks: 0
        Local Written Blocks: 0
        Temp Read Blocks: 0
        Temp Written Blocks: 0
        I/O Read Time: 0.000
        I/O Write Time: 0.000
  - Node Type: "Sort"
    Parent Relationship: "Outer"
    Startup Cost: 77902.77
    Total Cost: 77904.58
    Plan Rows: 724
    Plan Width: 22
    Actual Startup Time: 3015.448
    Actual Total Time: 3016.298
    Actual Rows: 6384
    Actual Loops: 1
    Output:
      - "(\"substring\"(customer.c_phone, 1, 2))"
      - "customer.c_acctbal"
    Sort Key:
      - "(\"substring\"(customer.c_phone, 1, 2))"
    Sort Method: "quicksort"
    Sort Space Used: 492
    Sort Space Type: "Memory"
    Shared Hit Blocks: 3576
    Shared Read Blocks: 28760
    Shared Dirtied Blocks: 0
    Shared Written Blocks: 0
    Local Hit Blocks: 0
    Local Read Blocks: 0
    Local Dirtied Blocks: 0
    Local Written Blocks: 0
    Temp Read Blocks: 4266
    Temp Written Blocks: 4236
    I/O Read Time: 0.000
    I/O Write Time: 0.000
    Plans:
      - Node Type: "Hash Join"
        Parent Relationship: "Outer"
        Join Type: "Anti"
        Startup Cost: 64806.00
```

```
Total Cost: 77868.38
Plan Rows: 724
Plan Width: 22
Actual Startup Time: 2823.113
Actual Total Time: 3010.580
Actual Rows: 6384
Actual Loops: 1
Output:
  - "\"substring\"(customer.c_phone, 1, 2)"
  - "customer.c_acctbal"
Hash Cond: "(customer.c_custkey = orders.o_custkey)"
Shared Hit Blocks: 3571
Shared Read Blocks: 28760
Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 4266
Temp Written Blocks: 4236
I/O Read Time: 0.000
I/O Write Time: 0.000
Plans:
  - Node Type: "Seq Scan"
    Parent Relationship: "Outer"
    Relation Name: "customer"
    Schema: "public"
    Alias: "customer"
    Startup Cost: 0.00
    Total Cost: 7128.50
    Plan Rows: 1750
    Plan Width: 26
    Actual Startup Time: 266.742
    Actual Total Time: 331.188
    Actual Rows: 19000
    Actual Loops: 1
    Output:
      - "customer.c_phone"
      - "customer.c_acctbal"
      - "customer.c_custkey"
    Filter: "((customer.c_acctbal > $0) AND (\"substring\"(customer.c_phone
    Rows Removed by Filter: 131000
    Shared Hit Blocks: 3568
    Shared Read Blocks: 3564
```

Shared Dirtied Blocks: 0
Shared Written Blocks: 0
Local Hit Blocks: 0
Local Read Blocks: 0
Local Dirtied Blocks: 0
Local Written Blocks: 0
Temp Read Blocks: 0
Temp Written Blocks: 0
I/O Read Time: 0.000
I/O Write Time: 0.000
- Node Type: "Hash"
  Parent Relationship: "Inner"
  Startup Cost: 40196.00
  Total Cost: 40196.00
  Plan Rows: 1500000
  Plan Width: 4
  Actual Startup Time: 2556.069
  Actual Total Time: 2556.069
  Actual Rows: 1500000
  Actual Loops: 1
  Output:
    - "orders.o_custkey"
  Hash Buckets: 16384
  Hash Batches: 16
  Original Hash Batches: 16
  Peak Memory Usage: 3379
  Shared Hit Blocks: 0
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  Shared Written Blocks: 0
  Local Hit Blocks: 0
  Local Read Blocks: 0
  Local Dirtied Blocks: 0
  Local Written Blocks: 0
  Temp Read Blocks: 0
  Temp Written Blocks: 4108
  I/O Read Time: 0.000
  I/O Write Time: 0.000
  Plans:
    - Node Type: "Seq Scan"
      Parent Relationship: "Outer"
      Relation Name: "orders"
      Schema: "public"
      Alias: "orders"
      Startup Cost: 0.00

```
                    Total Cost: 40196.00
                    Plan Rows: 1500000
                    Plan Width: 4
                    Actual Startup Time: 0.706
                    Actual Total Time: 2167.669
                    Actual Rows: 1500000
                    Actual Loops: 1
                    Output:
                      - "orders.o_custkey"
                    Shared Hit Blocks: 0
                    Shared Read Blocks: 25196
                    Shared Dirtied Blocks: 0
                    Shared Written Blocks: 0
                    Local Hit Blocks: 0
                    Local Read Blocks: 0
                    Local Dirtied Blocks: 0
                    Local Written Blocks: 0
                    Temp Read Blocks: 0
                    Temp Written Blocks: 0
                    I/O Read Time: 0.000
                    I/O Write Time: 0.000
Triggers:
Execution Time: 3019.109
```