Federating Queries Using postgres_fdw

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Who Am I?

- A long-time programmer, working with PostgreSQL in the cloud

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- A long-time programmer, working with PostgreSQL in ~~the cloud~~ my butt

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- Now, a DBA, working with PostgreSQL on real machines with real disks

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PostgreSQL inheritance partitioning

```
create table transactions (
        id serial,
        user_id bigint,
        time_utc timestamp,
        int_value bigint,
        txt_value text,
        primary key (id)
);

create table transactions_201306 (
        like transactions including indexes,
        check
          (time_utc >= '2013-06-01' and
           time_utc < '2013-07-01')
) inherits (transactions);
```

PostgreSQL inheritance partitioning

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          (time_utc >= '2013-06-01' and
           time_utc < '2013-07-01')
) inherits (transactions);
```

You know this already

Old-school partitioning

```
create view transactions as (
        select * from transactions_201301
          union all
        select * from transactions_201302
          union all
        select * from transactions_201303
          union all
        select * from transactions_201304
          union all
        ...
);
```

Why don't we still use this?

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2. No "inherit indexes" without additional misdirection

Why don't we still use this?

1. No insert triggers on views
2. No "inherit indexes" without additional misdirection
3. Basically, we have a better option with inheritence partitioning

Postgres Foreign Data Wrapper

```
-- just once
create extension postgres_fdw;

-- once per data node
create server node0 foreign data wrapper postgres_fdw
  options (connection stuff);
create user mapping for app_user server node0;

-- once per table per node
create foreign table transactions_node0
  (table definition)
  server node0
  options (table_name 'transactions');
```

Federating, Old-school

```
create view transactions as (
        select * from transactions_node0
          union all
        select * from transactions_node1
          union all
        select * from transactions_node2
          union all
        select * from transactions_node3
          union all
        ...
);
```

Querying

```
primary=# explain select count(*) from transactions;
                                                QUERY PLAN
-----------------------------------------------------------------------------------------
 Aggregate  (cost=1767.38..1767.39 rows=1 width=0)
   ->  Append  (cost=100.00..1699.12 rows=27304 width=0)
         ->  Foreign Scan on transactions_node0
               (cost=100.00..212.39 rows=3413 width=0)
         ->  Foreign Scan on transactions_node1
               (cost=100.00..212.39 rows=3413 width=0)
         ->  Foreign Scan on transactions_node2
               (cost=100.00..212.39 rows=3413 width=0)
         ->  Foreign Scan on transactions_node3
               (cost=100.00..212.39 rows=3413 width=0)
         ->  Foreign Scan on transactions_node4
               (cost=100.00..212.39 rows=3413 width=0)
         ...
(10 rows)

Time: 1.226 ms
```

Querying

```
primary=# explain verbose select count(*) from transactions;
                                                  QUERY PLAN
-------------------------------------------------------------------------------------------------
 Aggregate  (cost=1767.38..1767.39 rows=1 width=0)
   Output: count(*)
   ->  Append  (cost=100.00..1699.12 rows=27304 width=0)
         ->  Foreign Scan on public.transactions_node0
               (cost=100.00..212.39 rows=3413 width=0)
                Remote SQL: SELECT NULL FROM public.transactions
         ->  Foreign Scan on public.transactions_node1
               (cost=100.00..212.39 rows=3413 width=0)
                Remote SQL: SELECT NULL FROM public.transactions
         ->  Foreign Scan on public.transactions_node2
               (cost=100.00..212.39 rows=3413 width=0)
                Remote SQL: SELECT NULL FROM public.transactions
         ...
(19 rows)

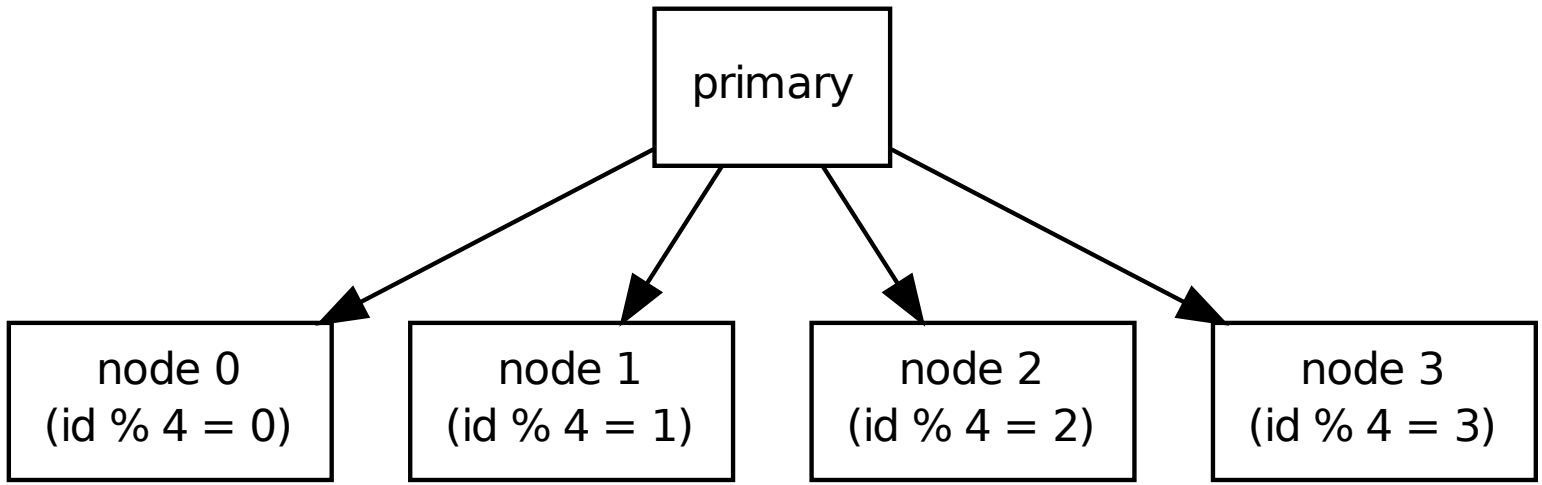
Time: 1.273 ms
```

Querying

```
primary=# select count(*) from transactions;
   count
---------
 1095336
(1 row)

Time: 3035.054 ms
```

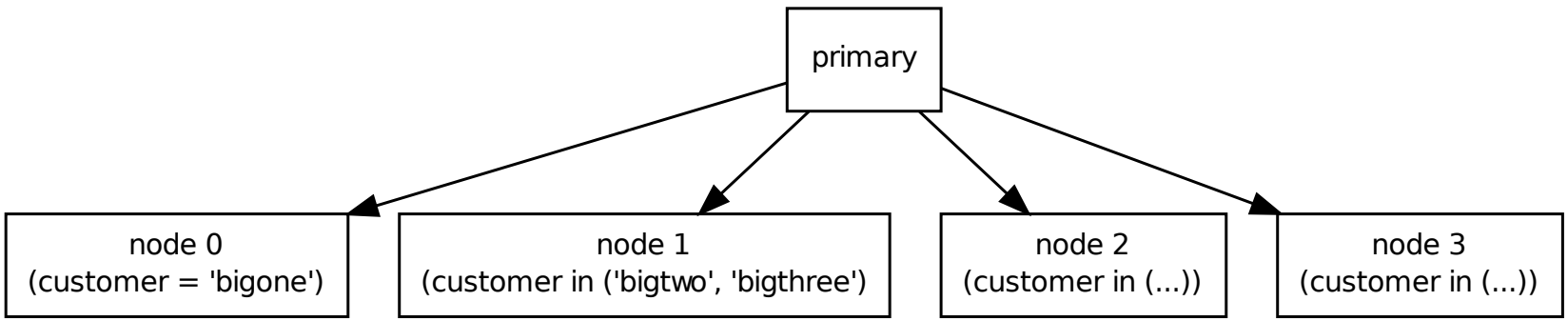
Round-robin



Round-robin

```
primary=# create foreign table transactions_node0 (
primary(#         id serial,
primary(#         user_id bigint,
primary(#         time_utc timestamp,
primary(#         int_value bigint,
primary(#         txt_value text,
primary(#         check ((id % 8) = 0)
primary(# ) server node0
primary(# options (table_name 'transactions');
ERROR:  constraints are not supported on foreign tables
LINE 6:         check ((id % 8) = 0)) server node0 ...
```

Domain-based (aka "sharding")



Range-based

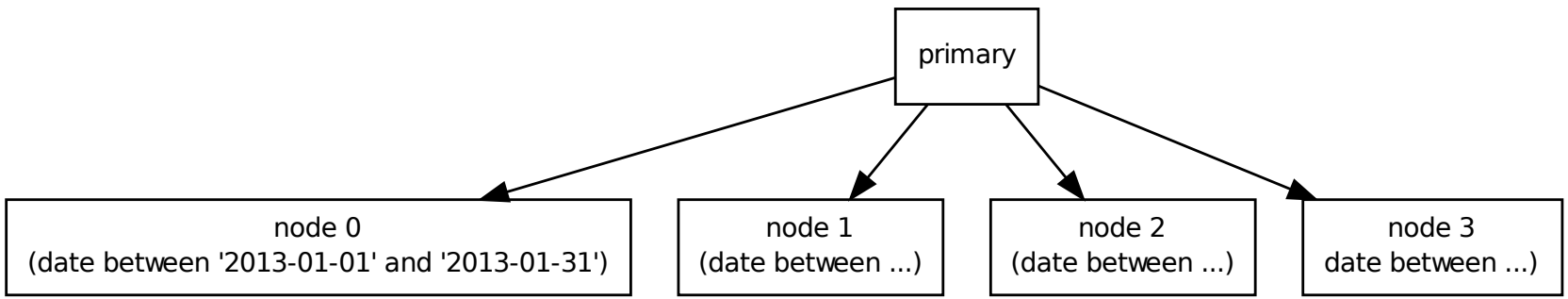
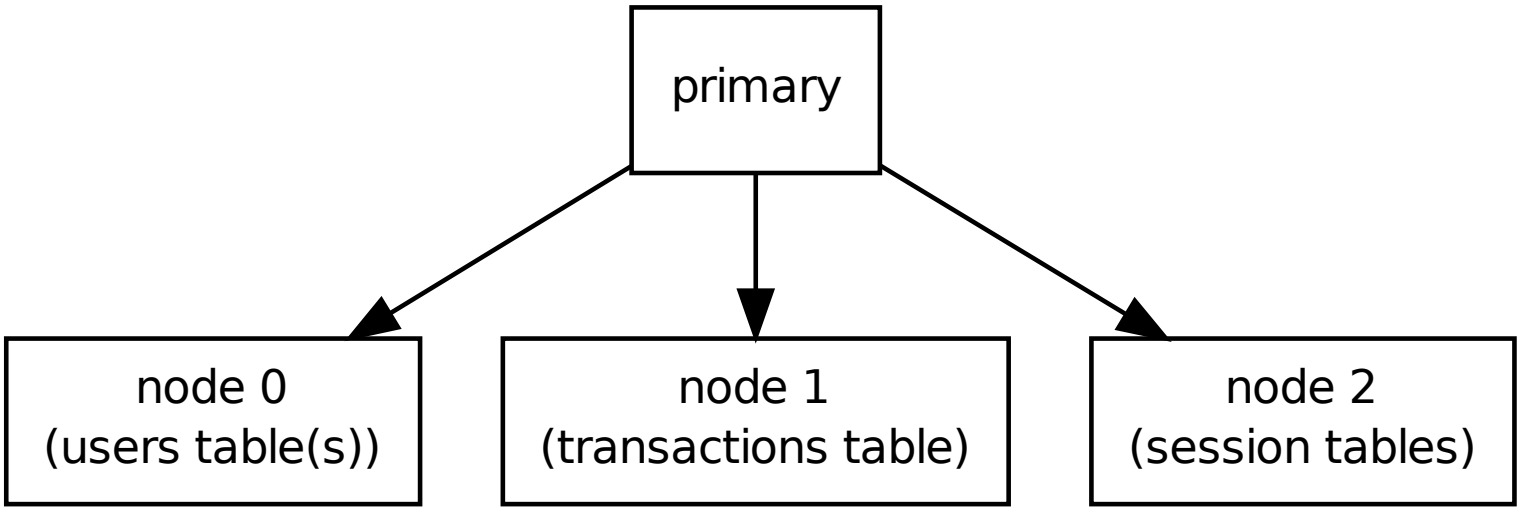
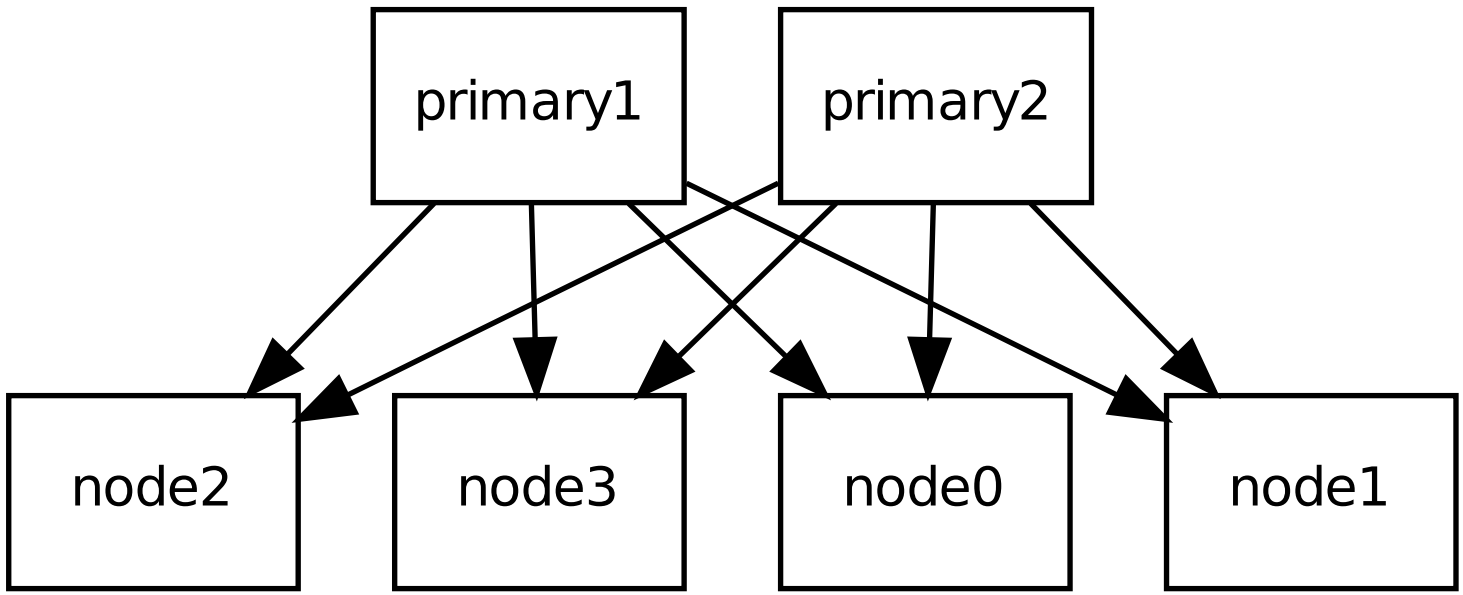

primary
node 0
(date between '2013-01-01' and '2013-01-31')
node 1
(date between ...)
node 2
(date between ...)
node 3
date between ...)

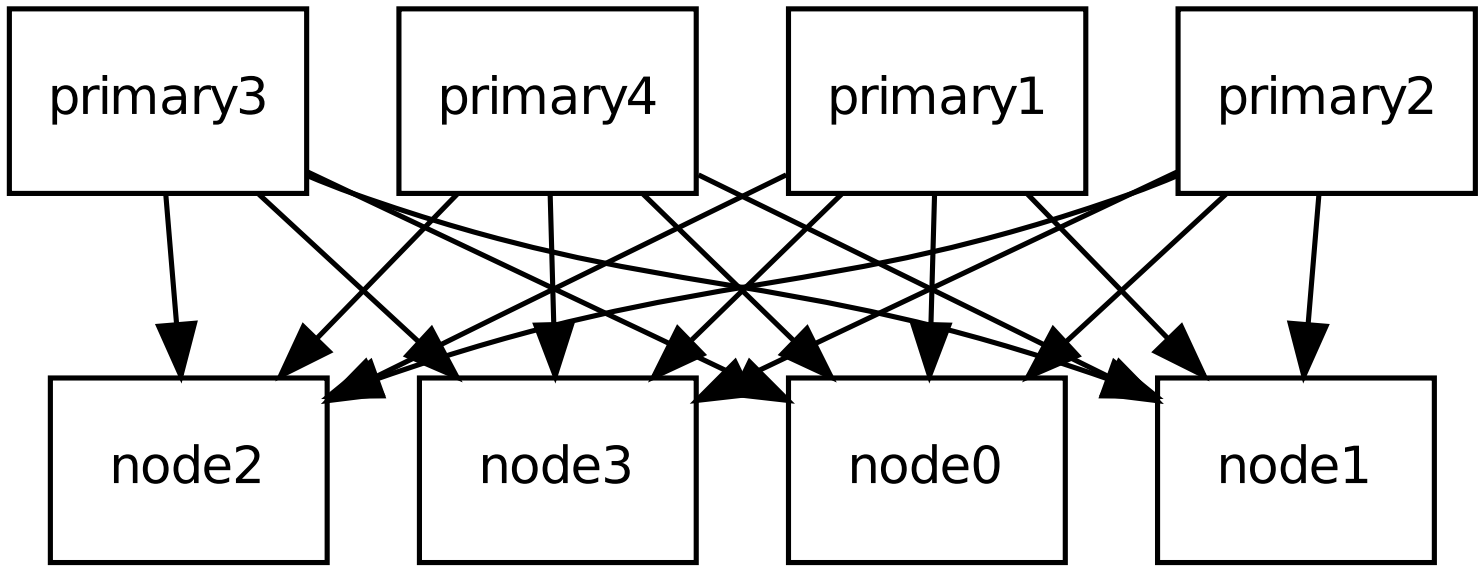
Table-based


primary
node 0
(users table(s))
node 1
(transactions table)
node 2
(session tables)

Multi-head



Multi-head


primary3
primary4
primary1
primary2
node2
node3
node0
node1

Demo time

Limitations: Network traffic

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```
primary=# select count(*) from transactions_local;
  count
---------
 1095336
(1 row)

Time: 209.097 ms
```

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```
primary=# select count(*) from transactions_local;
  count
---------
 1095336
(1 row)

Time: 209.097 ms
primary=# select count(*) from transactions_primary;
  count
---------
 1095336
(1 row)

Time: 2867.385 ms
```

Limitations: Dumb queries

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               (cost=100.00..212.39 rows=3413 width=0)
                Remote SQL: SELECT NULL FROM public.transactions
         ...
primary=# explain verbose select avg(int_value) from transactions;
                                                QUERY PLAN
-----------------------------------------------------------------------------------
 Aggregate  (cost=1545.60..1545.61 rows=1 width=8)
   Output: avg(transactions_node0.int_value)
   ->  Append  (cost=100.00..1494.40 rows=20480 width=8)
         ->  Foreign Scan on public.transactions_node0
               (cost=100.00..186.80 rows=2560 width=8)
                Output: transactions_node0.int_value
                   Remote SQL: SELECT int_value FROM public.transactions
         ...
```

Limitations: Dumb queries

```
select type, count(*)
from users
group by type
order by 2 desc;
```

Limitations: Joins

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```
select count(*)
from transactions t, users u
where t.user_id = u.id
 and u.type = 'mistaken';
```

Limitations: Keys

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'Nuff said

Limitations: Constraint exclusion

Remember this?

```
ERROR:  constraints are not supported on foreign tables
LINE 6:         check ((id % 8) = 0)) server node0 ....
```

Limitations: Single-threaded executer

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How many nodes do you have?

Limitations: Single-threaded executer

How many nodes do you have?
Do you know what they're doing?

Strategies

- Large working set, small nodes
- Node-level partitioning
- Heavy distributed processing
- Multi-head

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- (and network is faster than disk)

Strategy: Large working set, small nodes

- Your working set is larger than one node's RAM
- ... but you have lots of nodes
- (and network is faster than disk)
- This might be worth looking into if you're on AWS, but please, please test it first

Strategy: Node-level partitioning

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Like parititioning, but with a separate node per partition group! As a total strategy, this is probably not worthwhile. However, it can work with a fast "current data" node combining with slower "archived data" nodes.

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- Lock management can become a bit hairier
- This might actually be a useful use case

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Multi-headed

- Like replication, but with no overhead or delay!
- Also, no storage overhead!
- Might work well with the distributed processing setup
- In fact, given the overhead that lands on the head node, it might be necessary for a working FDW federation setup

Pan-Strategy Advice

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  - work_mem
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- Think very carefully about network vs. disk vs. dumb-query costs

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- Think very carefully!

Thanks!

Questions?

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John, do you use this approach for your databases?
Why not?

Thanks!

Thanks!

Plug: Stephen Frost has another postgres_fdw talk tomorrow

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Also: Rentrak is hiring: programmers, sysadmins, and devops

Federating Queries Using postgres_fdw