PostgresPro

Перепланирование запросов

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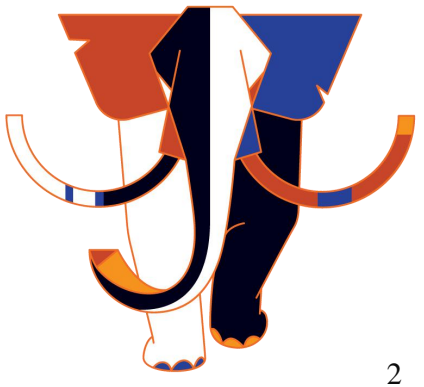
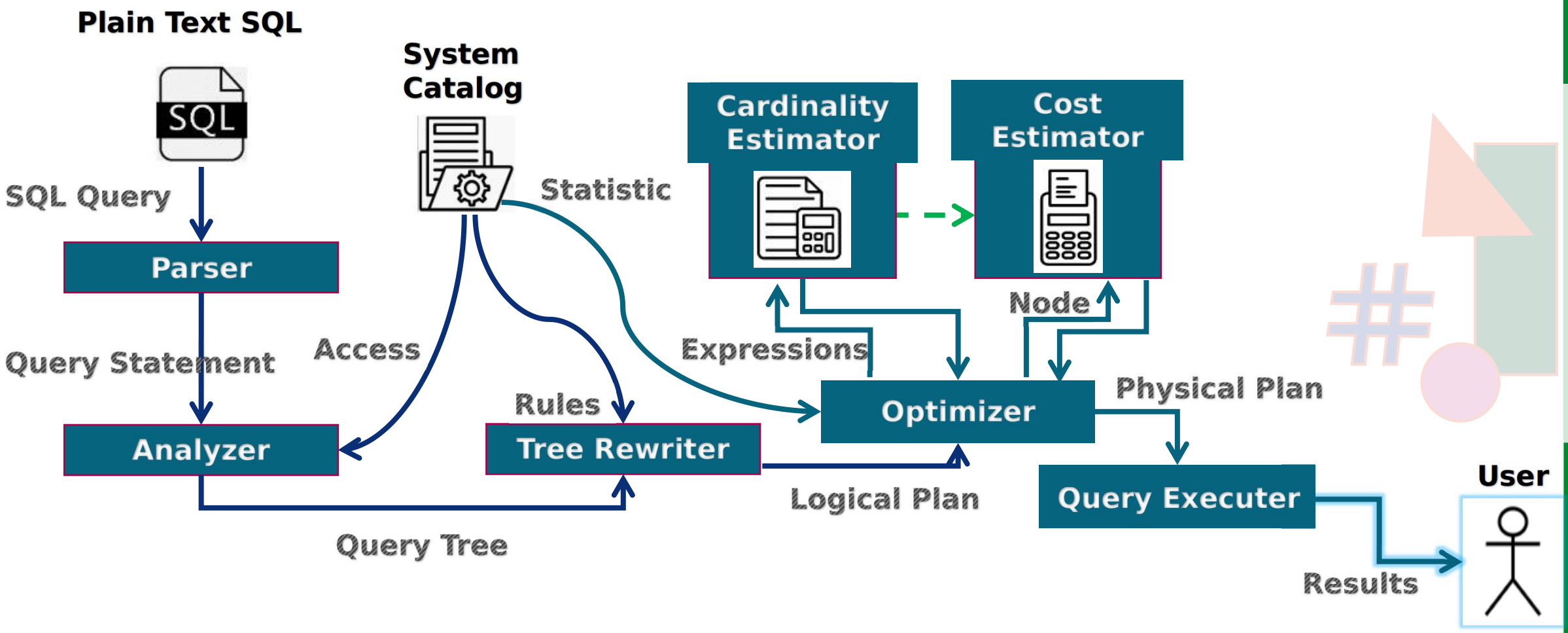
PostgresPro

- Как работает оптимизатор
- Основная проблема оптимизатора
- Возможные решения
- Как работает Replan
- Результаты тестирования Replan

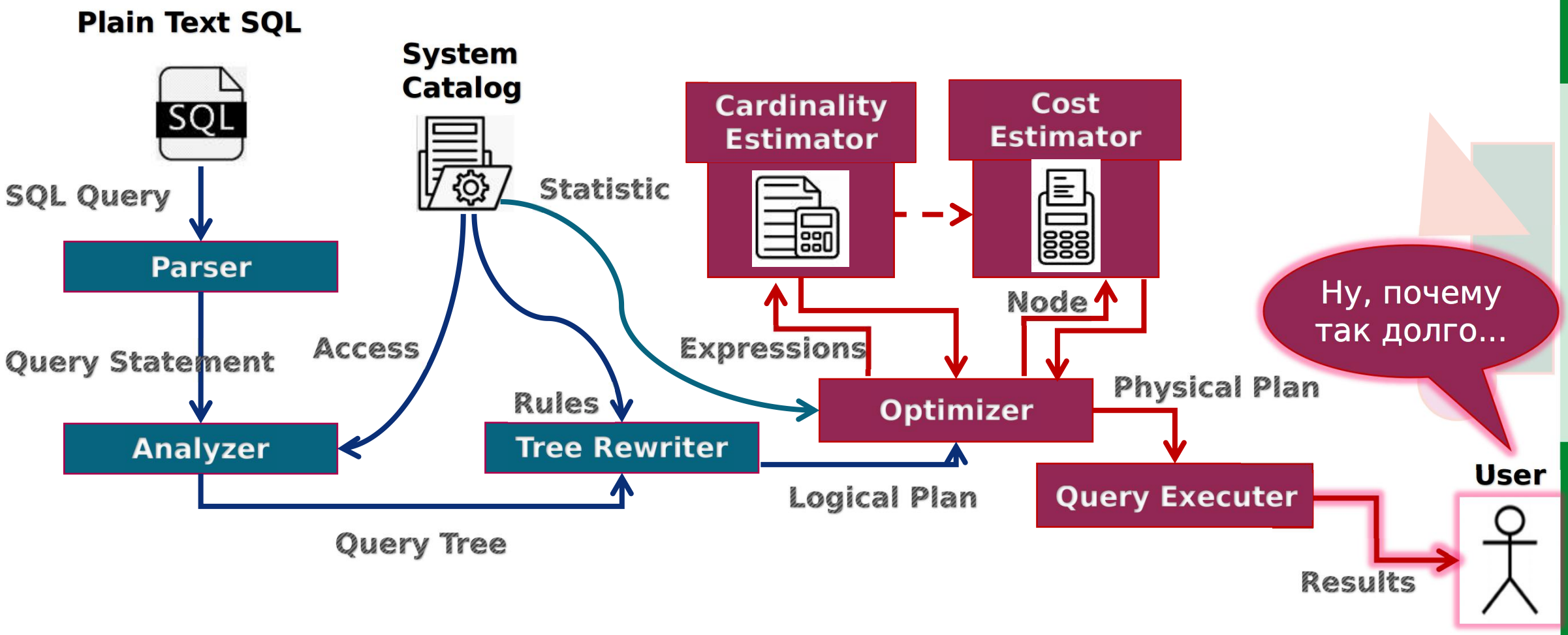


Устройство оптимизатора



Как работает оптимизатор | Основная проблема оптимизатора

Устройство оптимизатора



Как работает оптимизатор

Основная проблема оптимизатора

Проблема неточной оценки кардинальности

PostgresPro

Причины неточной оценки кардинальности

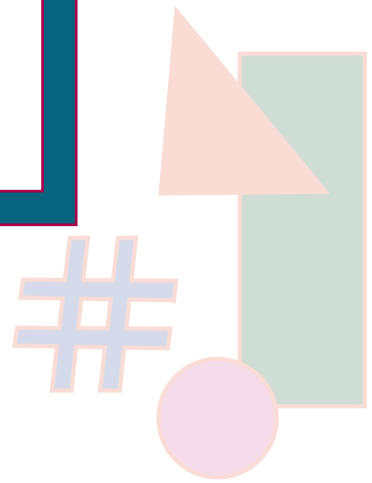
- использование устаревшей статистики
- Предположение о равномерном распределении между столбцами
- большое количество соединений в запросе

Основная проблема оптимизатора → Возможные решения

Предположения оптимизатора

Оптимизатор опирается на такие предположения

- **кардинальность предсказана всегда верно**
- **стоимость для плана всегда расчитана корректно**



Основная проблема оптимизатора → **Возможные решения**

Итак, проблема

Основная проблема оптимизатора → **Возможные решения**

Решения от PostgreSQL

О GEQO

Познакомимся с GEQO за 20 минут

ПАВЕЛ ТОЛМАЧЕВ

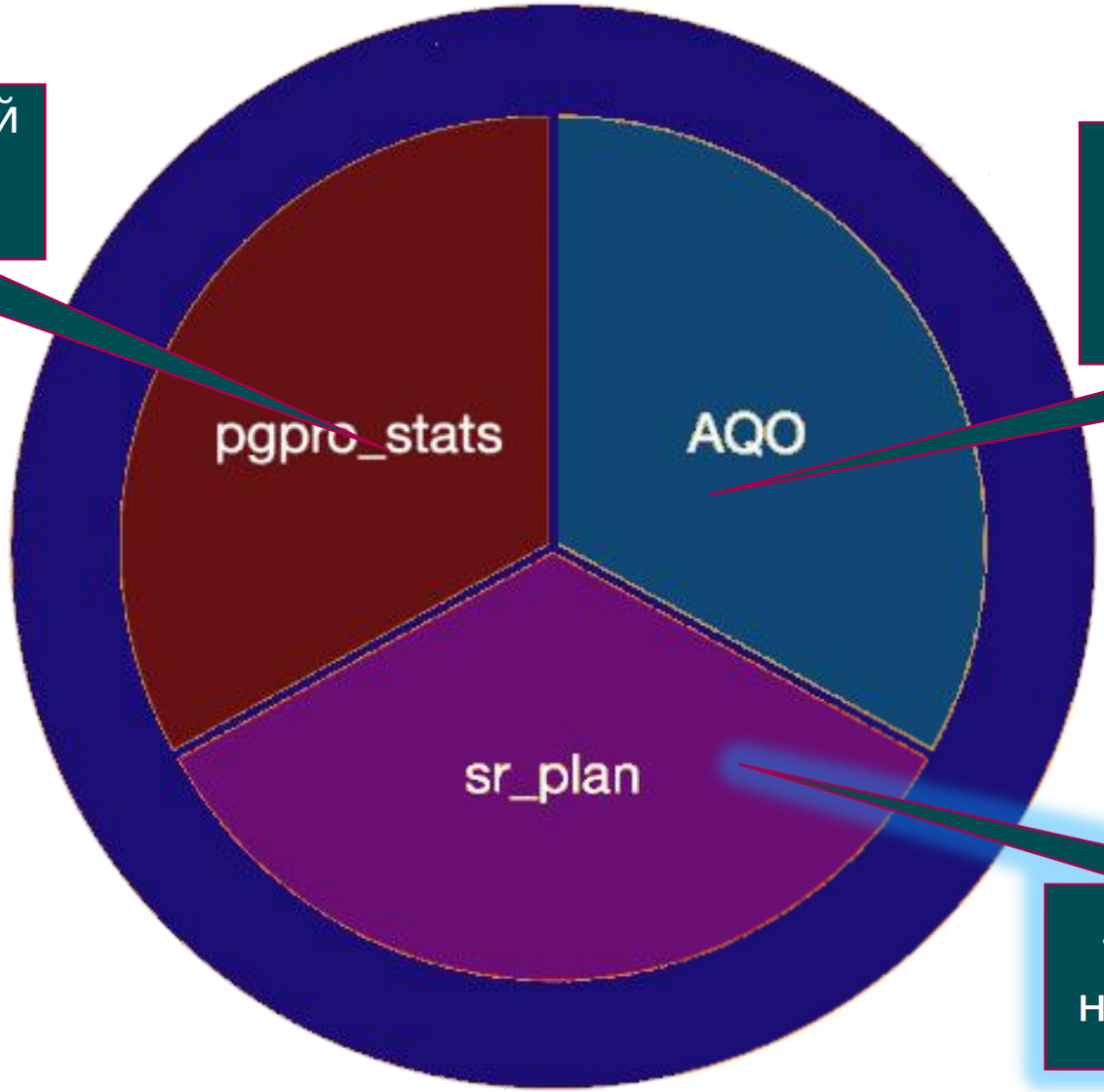
Postgres Professional

Специалист образовательного отдела

Генетический алгоритм GEQO

Возможные решения | **Как работает Replan**

Решения от PostgresPro Enterprise

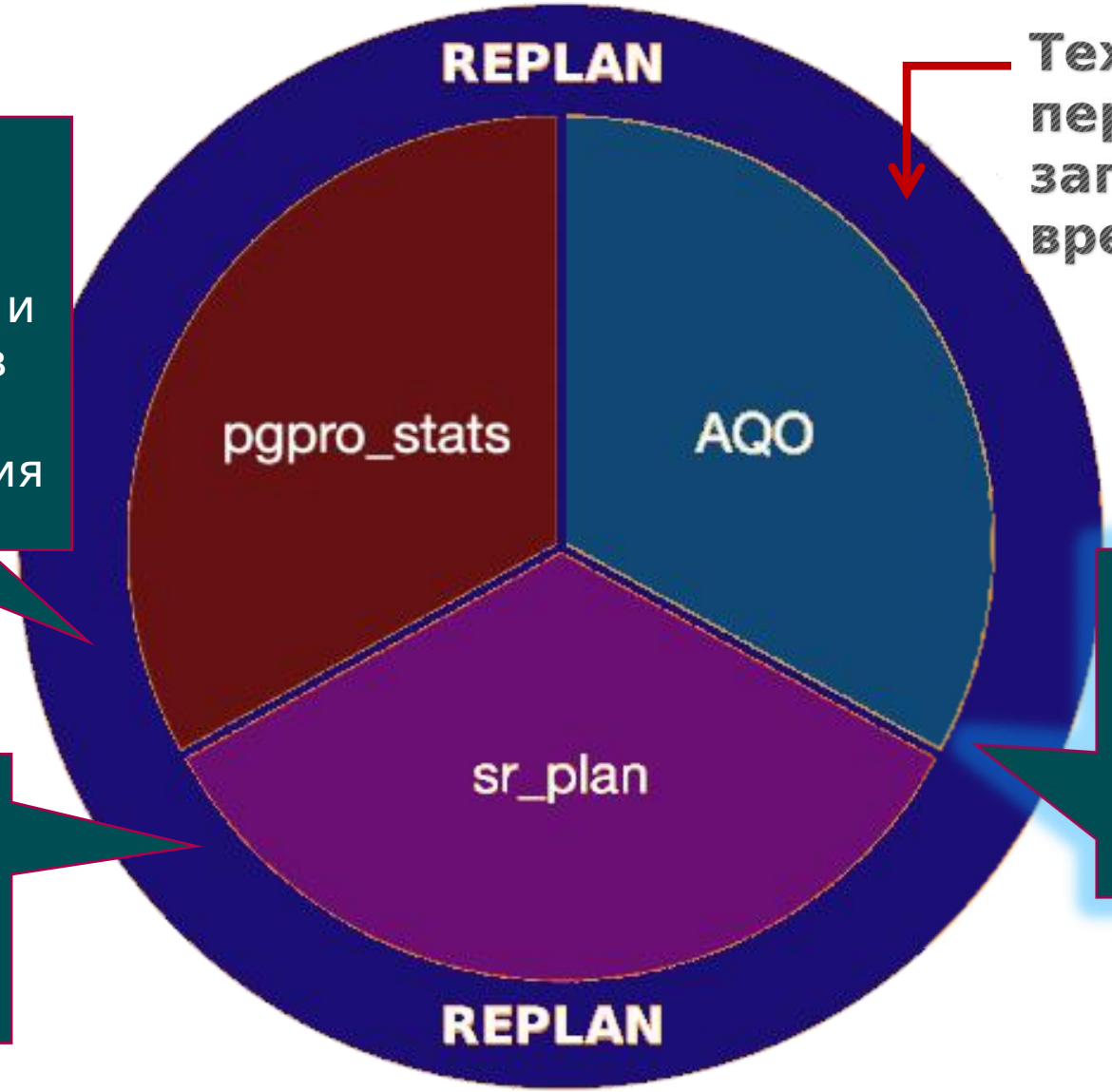


требуется ручной анализ и поиск лучшего плана

в основе него используется алгоритм Machine Learning, который может ошибаться

только фиксирует найденное решение

Решения от PostgresPro Enterprise



Технология перепланирования запроса в реальном времени

как и в AQO сохраняет кардинальности и использует их в новой попытке перепланирования

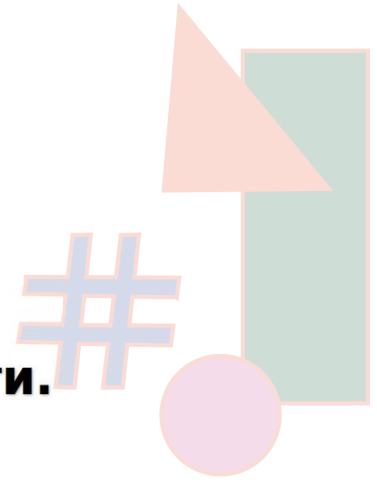
механизм перепланирования реализуется через сабтранзакции и триггер прерывания

решение о возможном перепланировании принимает оптимизатор

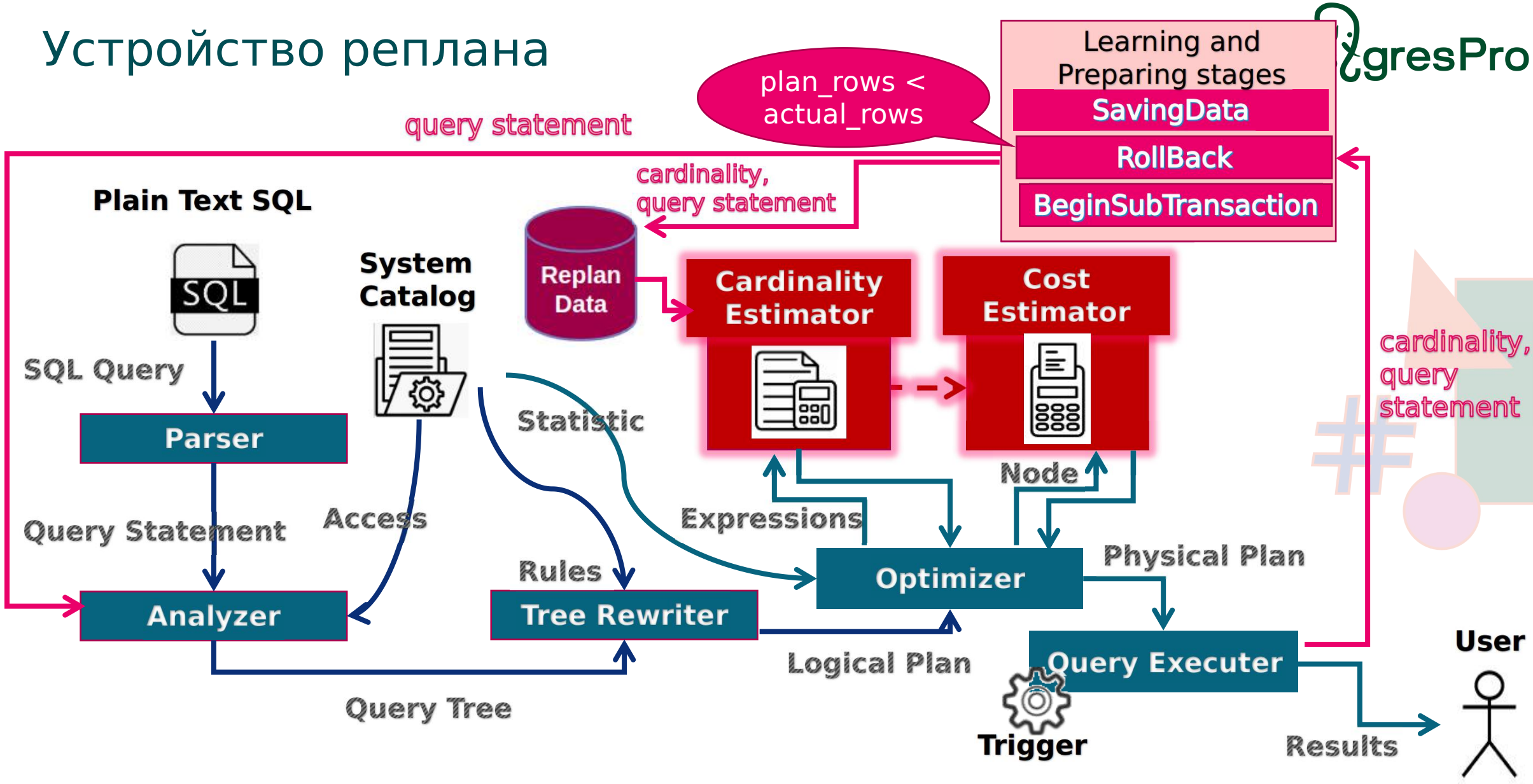
Две важные компоненты для реплана

Место хранения кардинальностей

Условие запуска перепланирования.
Может быть по времени, по кардинальности, по памяти.
Значения триггеров устанавливается пользователем.



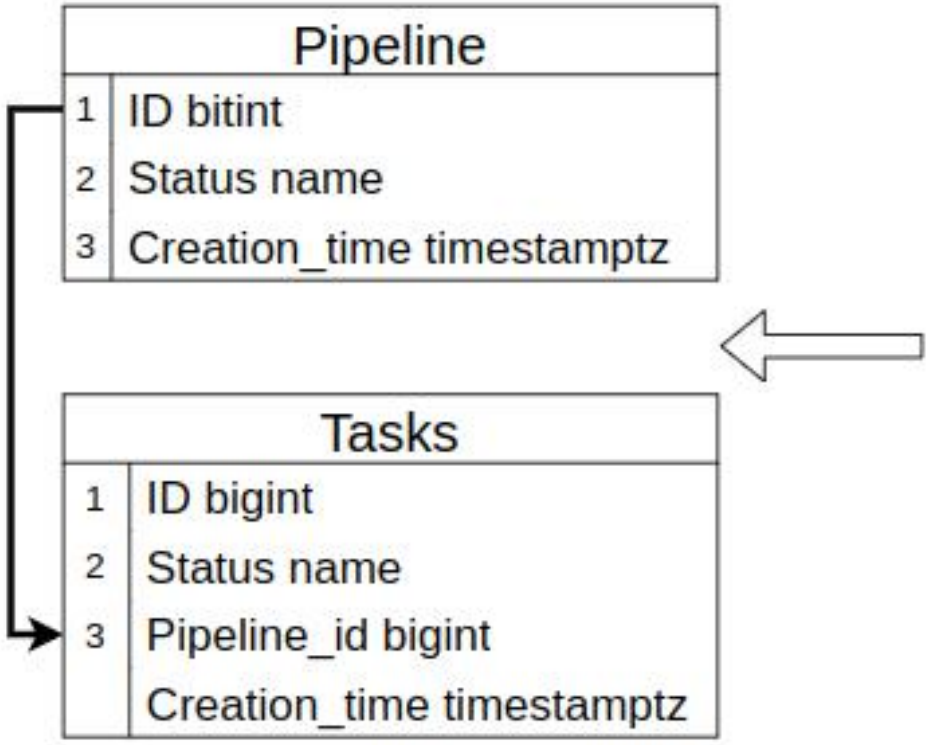
Устройство реплана



Как работает Replan

Результаты тестирования

Больше о Replan. Исходная база



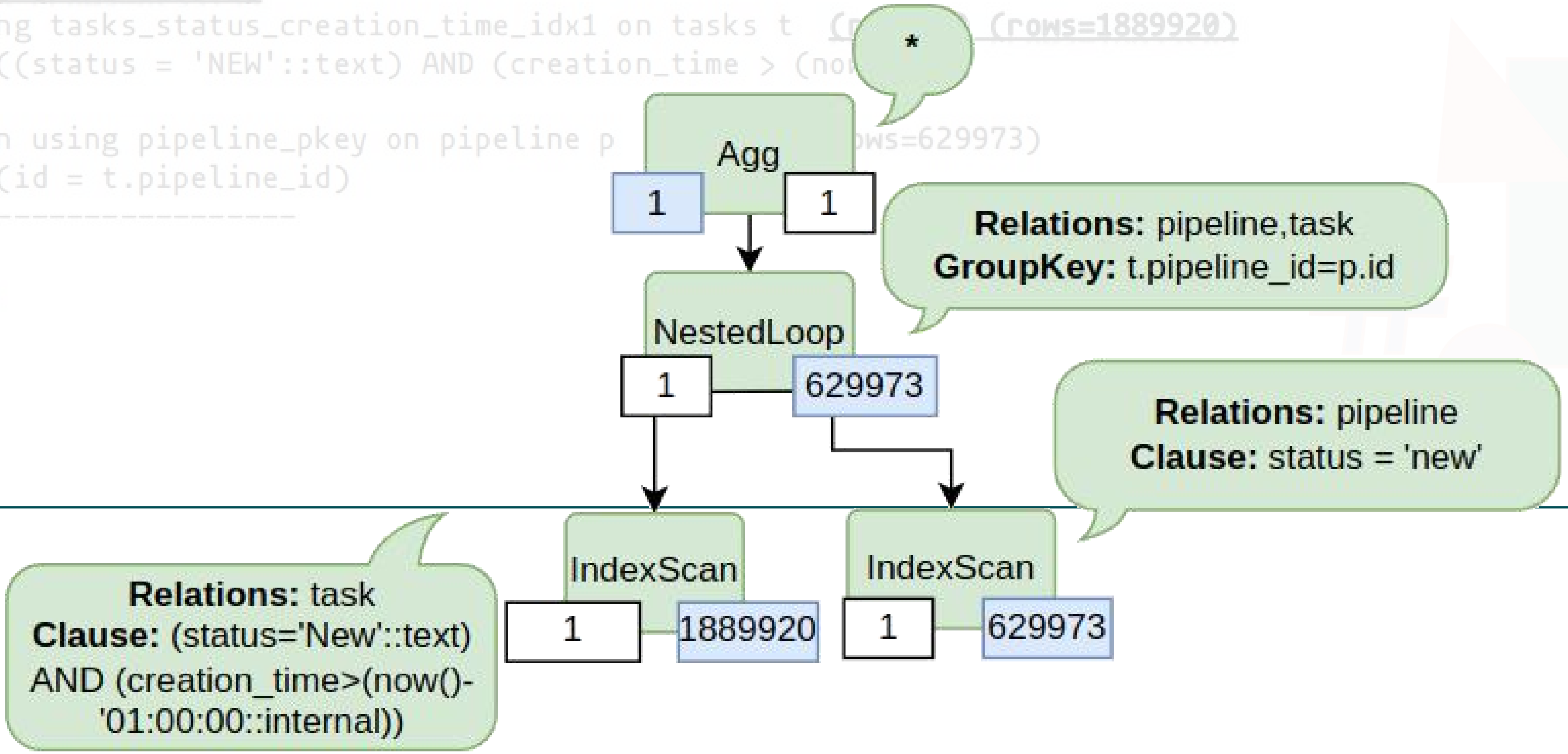
- генерируется 50000 pipelines
- в каждом pipeline генерируется по 5 задач
- status pipeline может быть New или Started
- status задач может быть New или Completed

Представление запроса

```
EXPLAIN ANALYZE SELECT count(1) FROM pipeline p,tasks t
  WHERE t.status = 'NEW' AND p.id = t.pipeline_id AND t.creation_time > now() - interval '1 hour';
------------------------------------------------------------------------------------------------
 Aggregate  (rows=1) (rows=1)
   ->  Nested Loop  (rows=1) (rows=629973)
         ->  Index Scan using tasks_status_creation_time_idx1 on tasks t  (rows=1) (rows=1889920)
               Index Cond: ((status = 'NEW'::text) AND (creation_time > (now() -
'01:00:00'::interval)))
         ->  Index Only Scan using pipeline_pkey on pipeline p  (rows=1) (rows=629973)
               Index Cond: (id = t.pipeline_id)
----------------------------------------
Planning Time: 1.045 ms
Execution Time: 9595.701 ms
```

Представление запроса

```
EXPLAIN ANALYZE SELECT count(1) FROM pipeline p,tasks t
  WHERE t.status = 'NEW' AND p.id = t.pipeline_id AND t.creation_time > now() - interval '1 hour';
-----------------------------------------------------------------------------------------------------
 Aggregate  (rows=1) (rows=1)
   ->  Nested Loop  (rows=1) (rows=629973)
         ->  Index Scan using tasks_status_creation_time_idx1 on tasks t  (r... (rows=1889920)
               Index Cond: ((status = 'NEW'::text) AND (creation_time > (no...
'01:00:00'::interval)))
         ->  Index Only Scan using pipeline_pkey on pipeline p ...ws=629973)
               Index Cond: (id = t.pipeline_id)
---------------------------------------------
Planning Time: 1.045 ms
Execution Time: 9595.701 ms
```



Explain запроса с репланом в терминале

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```
EXPLAIN ANALYZE SELECT count(1) FROM pipeline p,tasks t
  WHERE t.status = 'NEW' AND p.id = t.pipeline_id AND t.creation_time > now() - interval '1 hour';
------------------------------------------------------------------------------------------------
 Finalize Aggregate  (rows=1) (rows=1)
   ->  Gather  (rows=2) (rows=3)
         ->  Partial Aggregate  (rows=1) (rows=1)
               ->  Hash Join  (rows=8355) (rows=629973)
                     Hash Cond: (p.id = t.pipeline_id)
                     ->  Parallel Seq Scan on pipeline p  (rows=764484) (rows=628661)
                     ->  Hash  (rows=240357) (rows=1889920)
                           ->  Index Scan using tasks_status_creation_time_idx1 on tasks t
                                                                  (rows=240357) (rows=1889920)
                                 Index Cond: ((status = 'NEW'::text) AND (creation_time > (now() -
'01:00:00'::interval)))
-----------------------------------------
 Planning Time: 0.452 ms
 Replanning Attempts: 5
                                 Execution Time: 2229.972 ms
                                 Total Execution Time: 2964.835 ms
```

Лог реплана

```
2023-09-21 13:31:49.469 MSK [8320] LOG:  Replanning triggered by timeout 100 (0-th shift) ms.
    Attempt: 1.
    Duration: 158.919477 ms  plan:
    Query Text: explain (analyze) select count(1) from pipeline p,tasks t...
    Finalize Aggregate  (cost=30098.31..30098.32 rows=1 width=8) (actual time=162.220..162.220
    rows=0 loops=1) (early terminated)
          NodeSign: 4304986849338732187
          Cardinality: -1
          Groups Number: -1
          Output: count(1)...
2023-09-21 13:31:49.957 MSK [8320] LOG:  Replanning triggered by timeout 100 (0-th shift) ms.
    Attempt: 4.
    Duration: 156.986469 ms  plan:
    Query Text: explain (analyze) select count(1) from pipeline p,tasks t...
    Finalize Aggregate  (cost=41139.66..41139.67 rows=1 width=8) (actual time=160.432..160.432
rows=0 loops=1) (early terminated)
      NodeSign: 4304986849338732187
      Cardinality: -1
      Groups Number: -1
      Output: count(1)...
```

Улучшать уже нечего

```
EXPLAIN ANALYZE SELECT count(1) FROM pipeline p,tasks t
     WHERE p.status = 'STARTED' AND p.id = t.pipeline_id and t.status IN ('NEW', 'COMPLETED')
       AND t.creation_time > now() - interval '1 hour';
-----------------------------------------------------------
 Aggregate  (rows=1) (rows=1)
   ->  Nested Loop  (rows=9) (rows=25000)
         ->  Index Scan using pipeline_status_idx on pipeline p  (rows=1) (rows=5000)
               Index Cond: (status = 'STARTED'::text)
         ->  Index Scan using tasks_pipeline_id_idx on tasks t  (rows=5) (rows=5)
               Index Cond: (pipeline_id = p.id)
               Filter: ((status = ANY ('{NEW,COMPLETED}'::text[])) AND (creation_time > (now() -
'01:00:00'::interval)))
---------------------------------------
Planning Time: 3.043 ms
 Execution Time: 43.531 ms
(9 rows)
```

Улучшать уже нечего

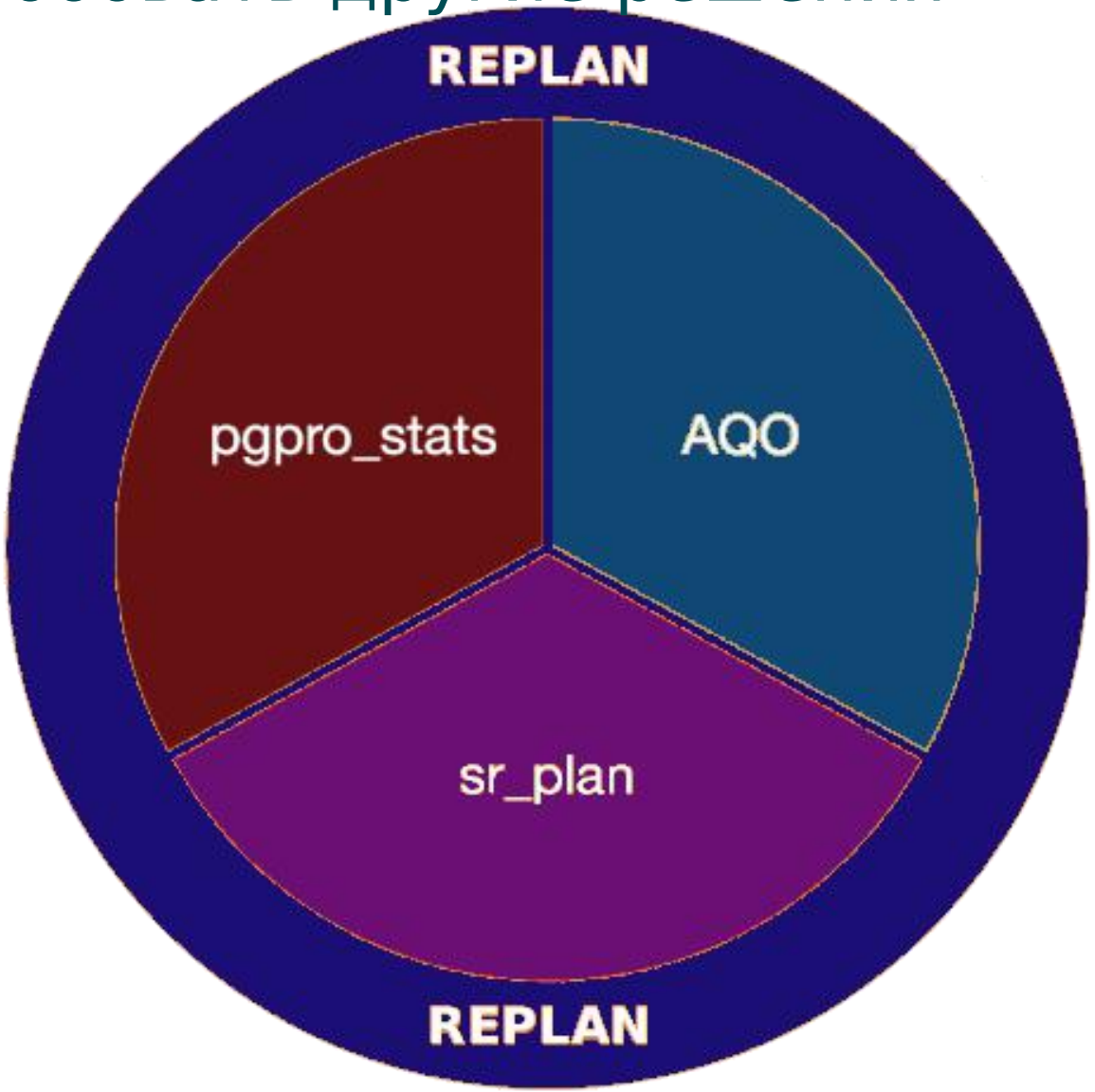
```
EXPLAIN ANALYZE SELECT count(1) FROM pipeline p,tasks t
     WHERE p.status = 'STARTED' AND p.id = t.pipeline_id and t.status IN ('NEW', 'COMPLETED')
       AND t.creation_time > now() - interval '1 hour';
-------------------------------------------------------------
 Aggregate  (rows=1) (rows=1)
   ->  Hash Join  (rows=491) (rows=25000)
         Hash Cond: (t.pipeline_id = p.id)
         ->  Index Scan using tasks_status_creation_time_idx on tasks t  (rows=24752) (rows=25000)
               Index Cond: ((status = 'NEW'::text) AND (creation_time > (now() -
'01:00:00'::interval)))
         ->  Hash  (rows=99) (rows=5000)
               ->  Index Scan using pipeline_status_idx on pipeline p  (rows=99) (rows=5000)
                     Index Cond: (status = 'STARTED'::text)

 Planning Time: 0.414 ms
 Execution Time: 22.380 ms
 Replanning Attempts: 1
 Total Execution Time: 1025.460 ms
```

Что Реплан вылечить не сможет

1. **Запрос просто может быть написан плохо**

2. **Replan потребуется большое количество итераций, чтобы найти лучший план**

Стоит попробовать другие решения



Интернет-база данных фильмов (IMDB)

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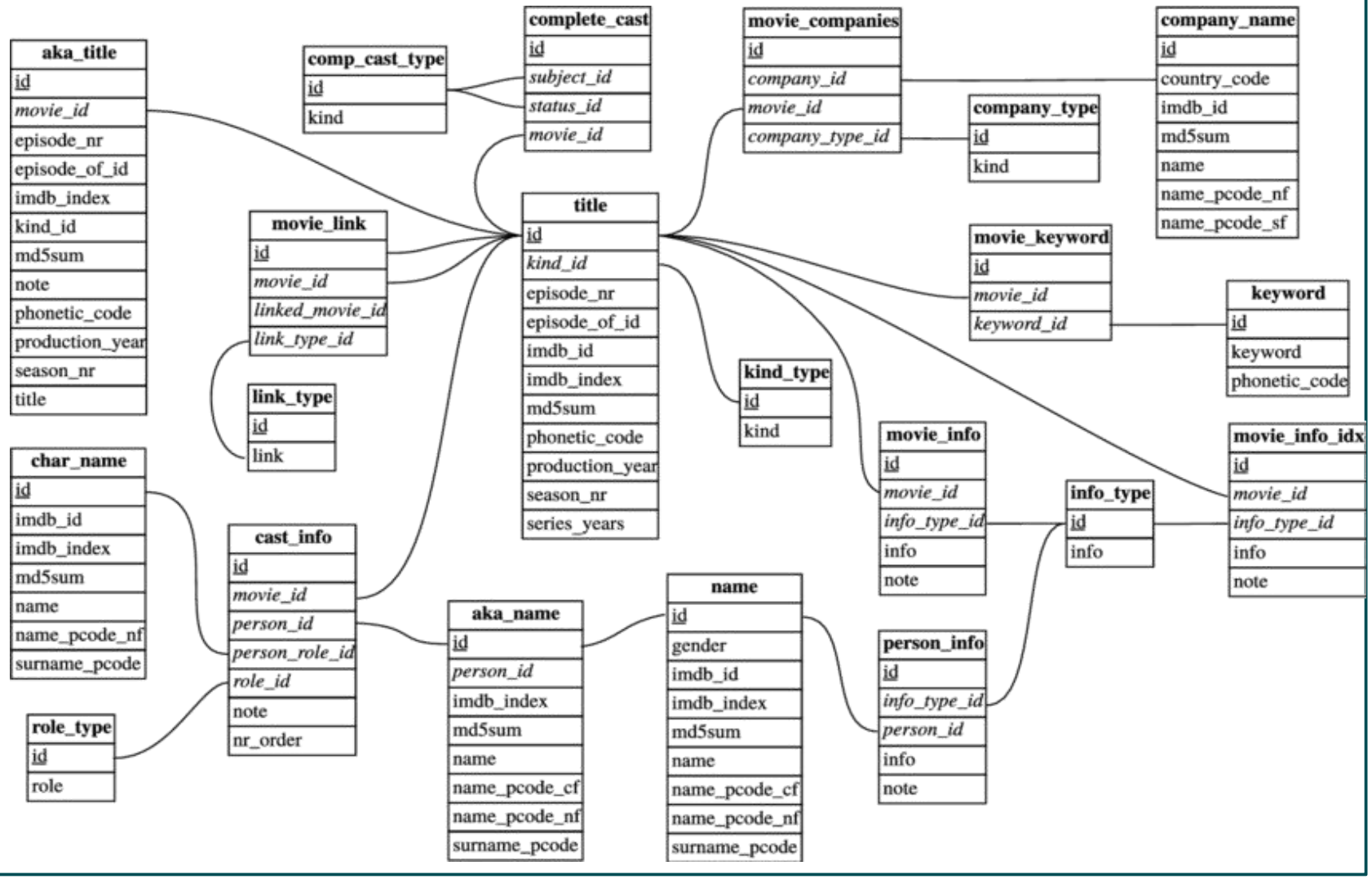
Join Order Benchmark (JOB)

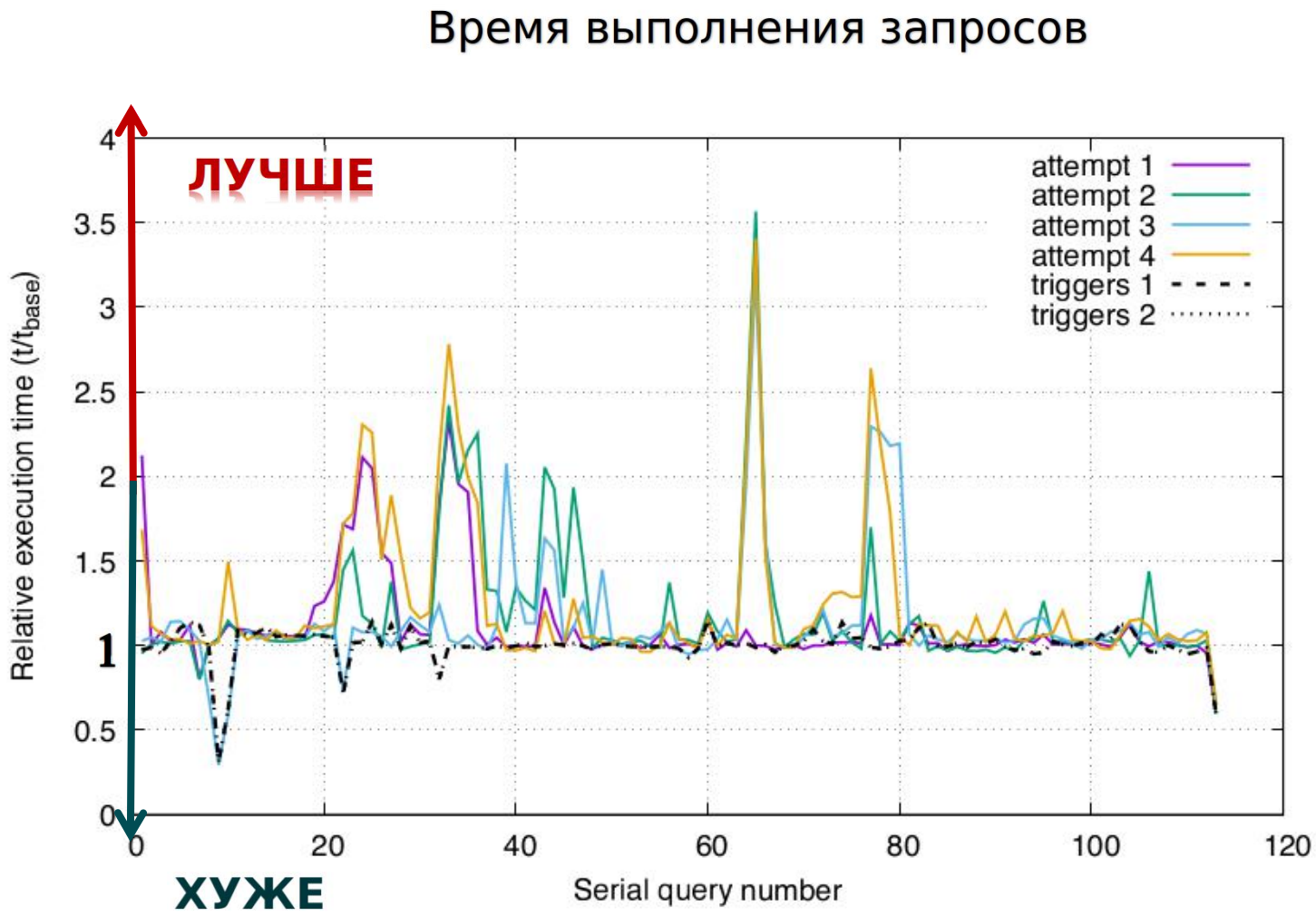
- **состоит из 113 запросов по IMDB**
- **каждый запрос может иметь от 3 до 16 соединений**
- **запросы отвечают на логичные вопросы любителя кино**
- **для оптимизатора запросы сложные из-за большого количества объединений и корреляций**



Результаты тестирования

Тестирование на Join Order Benchmark

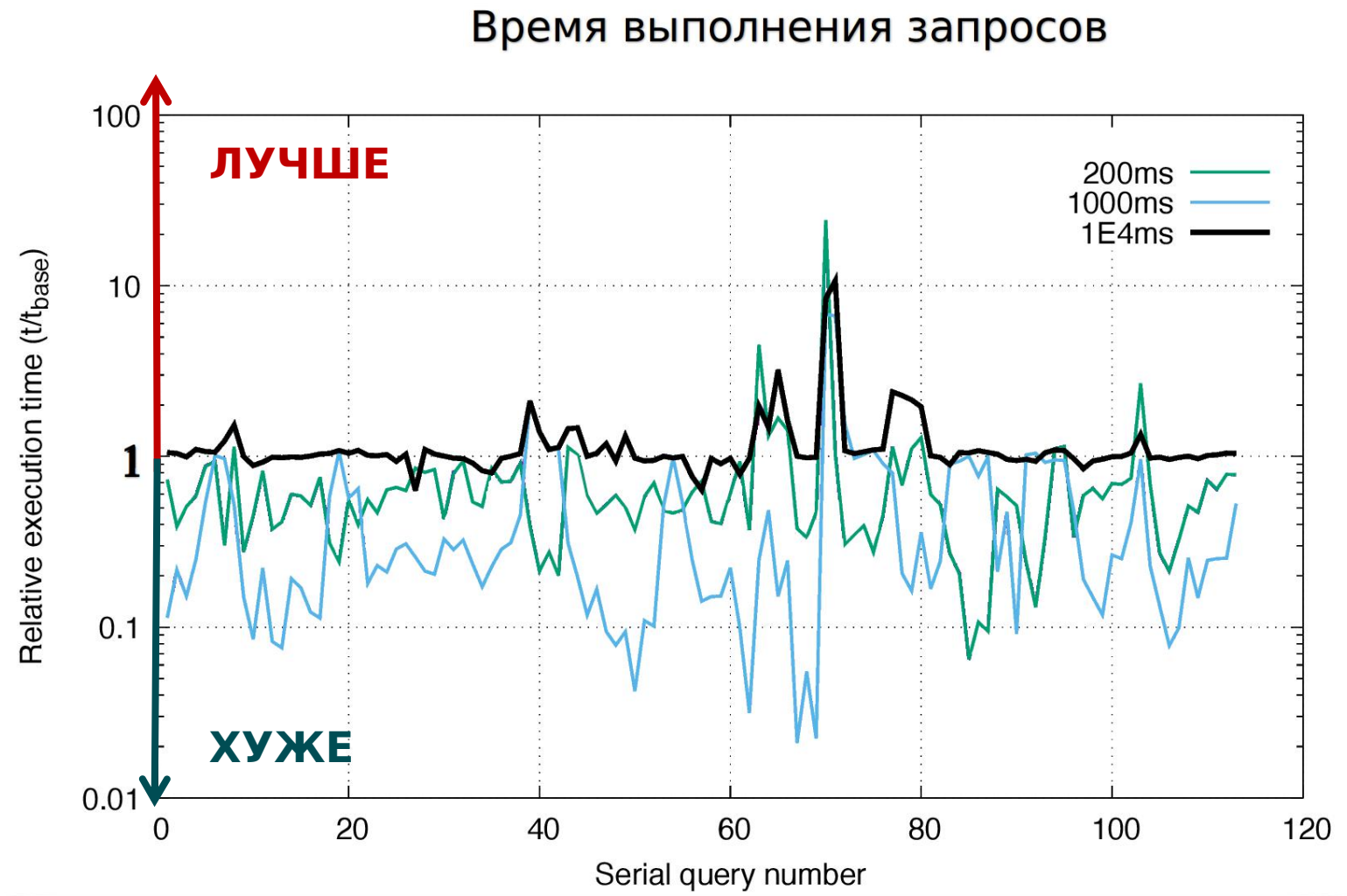
Время выполнения запроса в JOB может сильно меняться от запуска к запуску



Результаты тестирования

Тестирование на Join Order Benchmark

Время выполнения запроса после перепланирования может ухудшиться

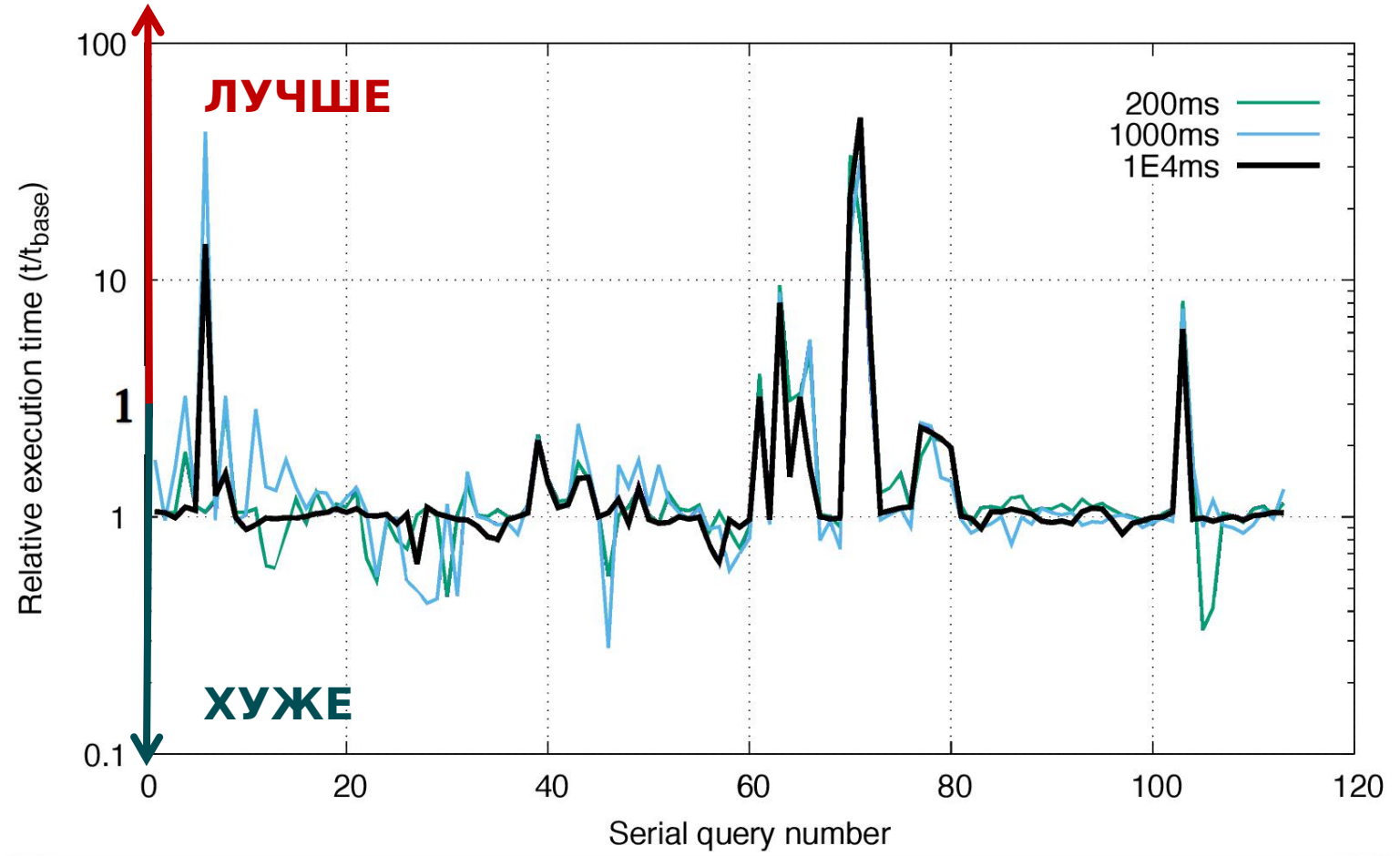


Результаты тестирования

Тестирование на Join Order Benchmark

Итоговое время потраченное на перепланирование запросов

Перепланирование – крайняя мера



Результаты тестирования

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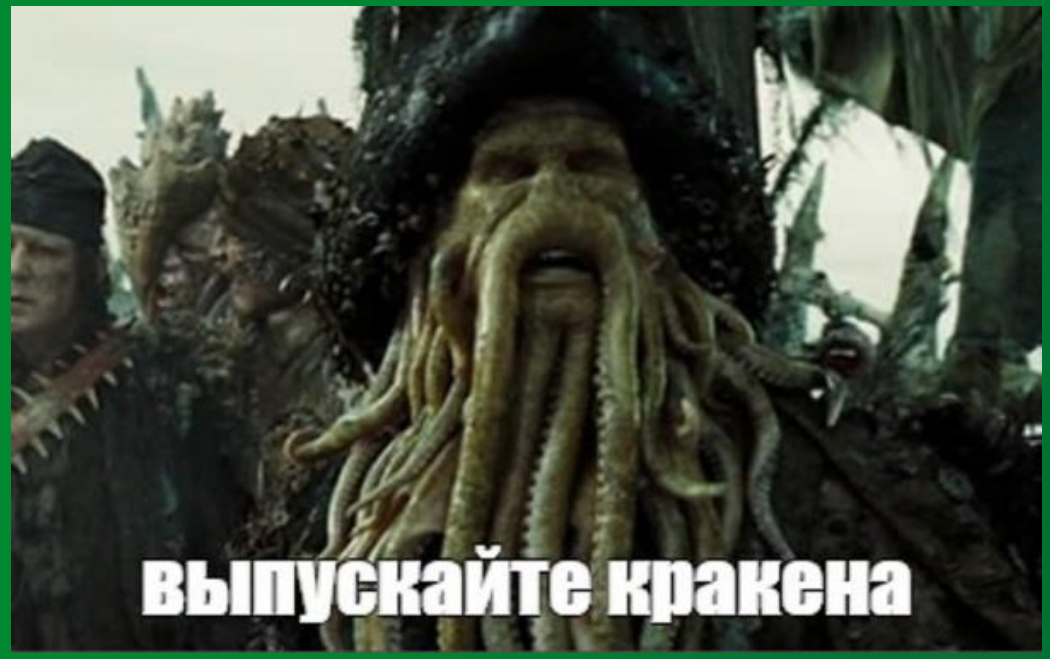
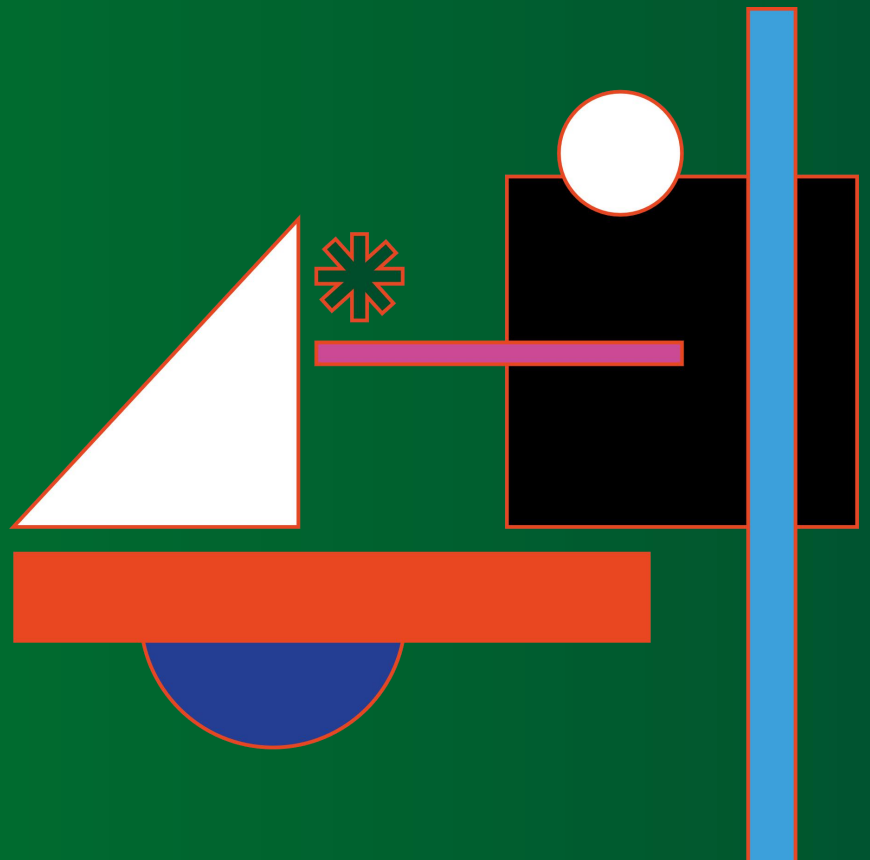
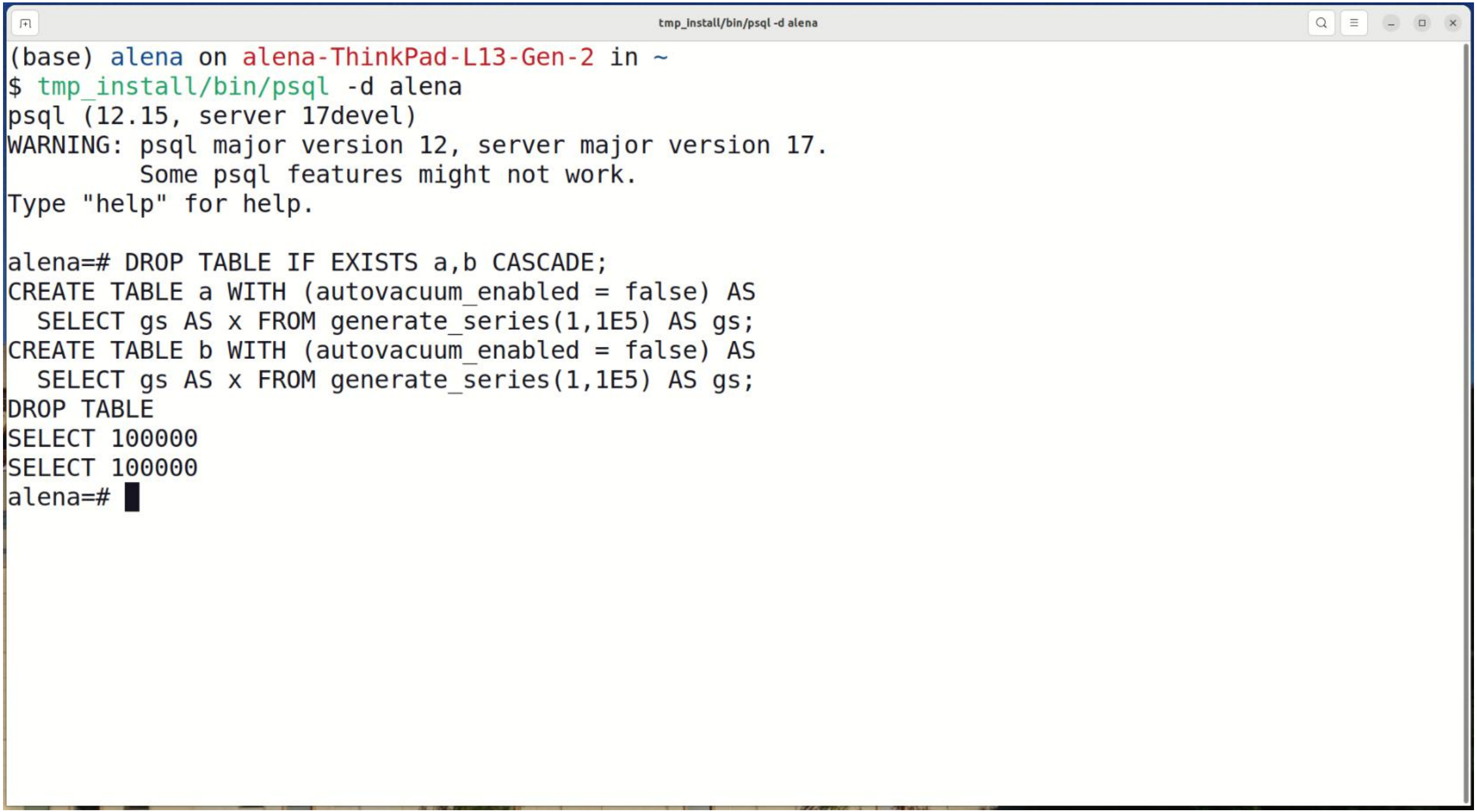
А теперь ДЕМО






tmp_install/bin/psql -d alena
(base) alena on alena-ThinkPad-L13-Gen-2 in ~
$ tmp_install/bin/psql -d alena
psql (12.15, server 17devel)
WARNING: psql major version 12, server major version 17.
Some psql features might not work.
Type "help" for help.
alena=# DROP TABLE IF EXISTS a,b CASCADE;
CREATE TABLE a WITH (autovacuum_enabled = false) AS
SELECT gs AS x FROM generate_series(1,1E5) AS gs;
CREATE TABLE b WITH (autovacuum_enabled = false) AS
SELECT gs AS x FROM generate_series(1,1E5) AS gs;
DROP TABLE
SELECT 100000
SELECT 100000
alena=#

tmp_install/bin/psql -d alena

```
(base) alena on alena-ThinkPad-L13-Gen-2 in ~
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  SELECT gs AS x FROM generate_series(1,1E5) AS gs;
DROP TABLE
SELECT 100000
SELECT 100000
alena=# ANALYZE a,b;
INSERT INTO a SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
INSERT INTO b SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
ANALYZE
INSERT 0 100
INSERT 0 100
alena=#
```

```
psql (12.15, server 17devel)
WARNING: psql major version 12, server major version 17.
         Some psql features might not work.
Type "help" for help.

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alena=# ANALYZE a,b;
INSERT INTO a SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
INSERT INTO b SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
ANALYZE
INSERT 0 100
INSERT 0 100
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=#
```

tmp_install/bin/psql -d alena

```
Type "help" for help.

alena=# DROP TABLE IF EXISTS a,b CASCADE;
CREATE TABLE a WITH (autovacuum_enabled = false) AS
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ANALYZE
INSERT 0 100
INSERT 0 100
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=# EXPLAIN (ANALYZE, COSTS ON)
SELECT count(*) FROM a,b WHERE a.x=b.x AND b.x = 1
; -- Bad plan and execution time
```
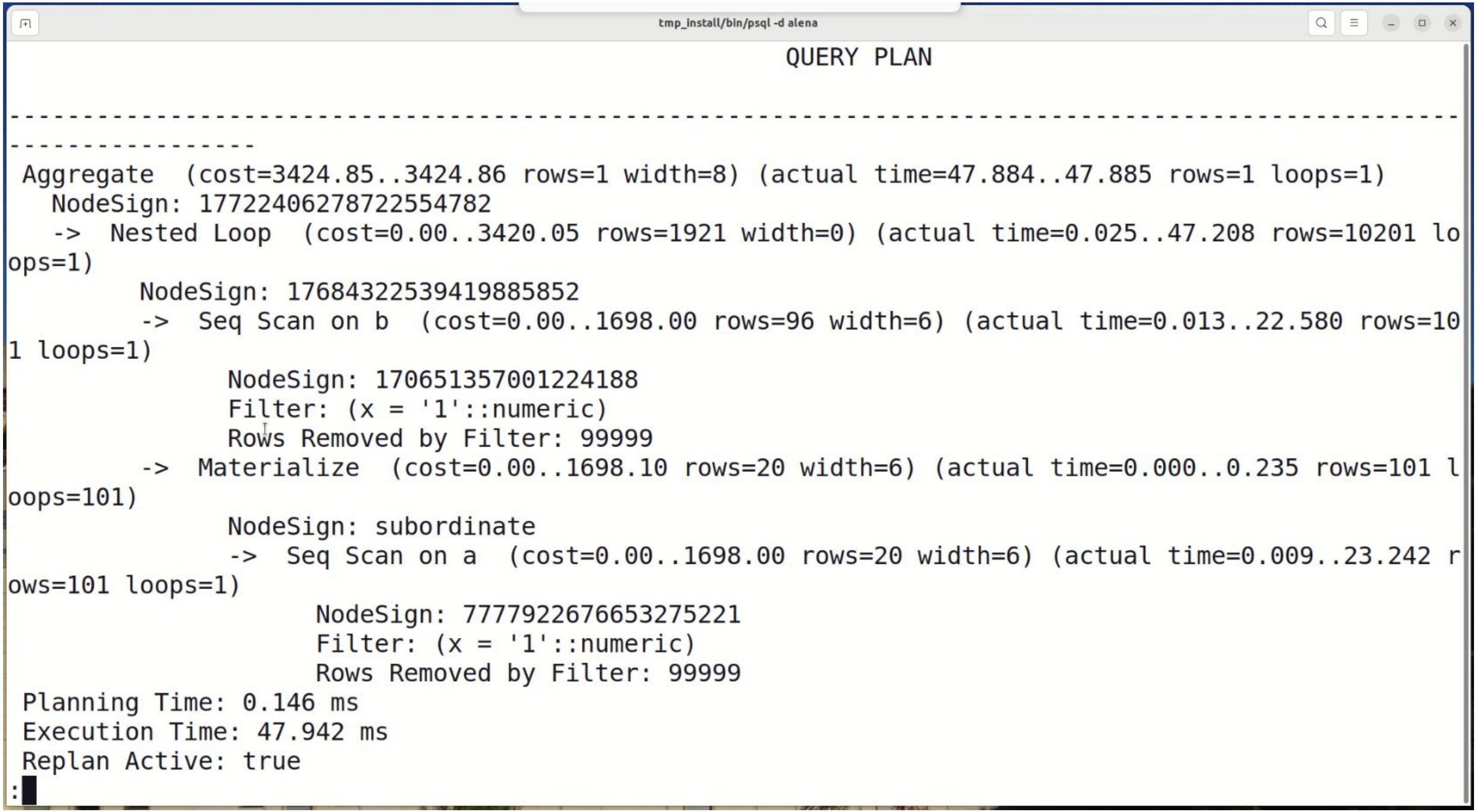
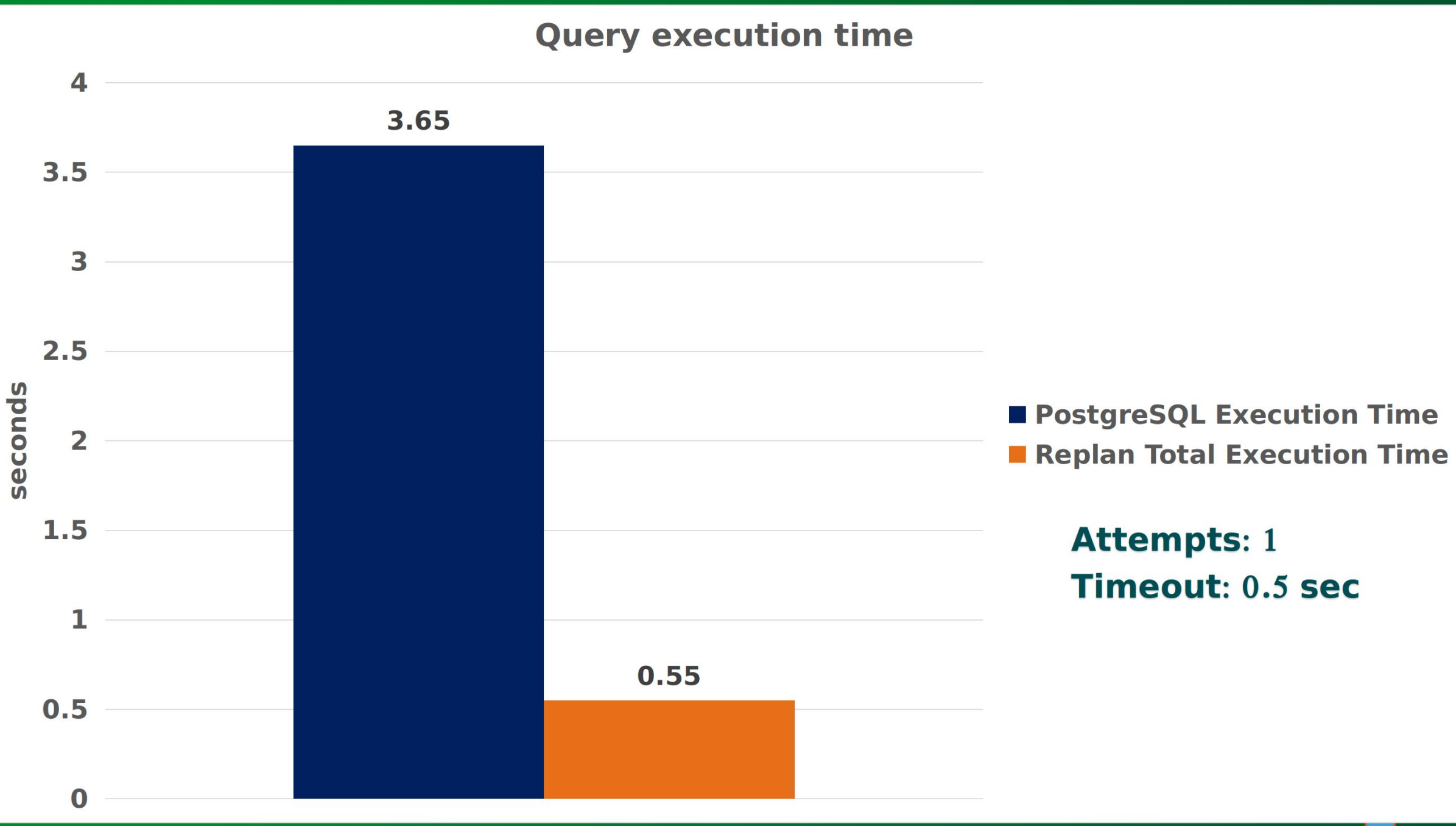

tmp_install/bin/psql -d alena

```
                                                  QUERY PLAN
-----------------------------------------------------------------------------------------------------
------------
 Aggregate  (cost=3396.01..3396.02 rows=1 width=8) (actual time=2453.918..2453.919 rows=1 loops=1)
   ->  Nested Loop  (cost=0.00..3396.01 rows=1 width=0) (actual time=0.065..2452.964 rows=10201 loo
ps=1)
         ->  Seq Scan on a  (cost=0.00..1698.00 rows=1 width=6) (actual time=0.037..27.978 rows=101
 loops=1)
               Filter: (x = '1'::numeric)
               Rows Removed by Filter: 99999
         ->  Seq Scan on b  (cost=0.00..1698.00 rows=1 width=6) (actual time=0.007..23.998 rows=101
 loops=101)
               Filter: (x = '1'::numeric)
               Rows Removed by Filter: 99999
 Planning Time: 0.514 ms
 Execution Time: 2453.987 ms
(10 rows)

(END)
```

```
  SELECT gs AS x FROM generate_series(1,1E5) AS gs;
DROP TABLE
SELECT 100000
SELECT 100000
alena=# ANALYZE a,b;
INSERT INTO a SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
INSERT INTO b SELECT 1 AS x FROM generate_series(1,1E2) AS gs;
ANALYZE
INSERT 0 100
INSERT 0 100
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=# EXPLAIN (ANALYZE, COSTS ON)
SELECT count(*) FROM a,b WHERE a.x=b.x AND b.x = 1
; -- Bad plan and execution time
alena=# SET show_node_sign = 'on';
SET query_inadequate_execution_time = 500;
SET
SET
alena=# EXPLAIN (ANALYZE, COSTS ON)
SELECT count(*) FROM a,b WHERE a.x=b.x AND b.x = 1
; -- Better plan and execution time
```


tmp_install/bin/psql -d alena
QUERY PLAN
Aggregate (cost=3424.85..3424.86 rows=1 width=8) (actual time=47.884..47.885 rows=1 loops=1)
NodeSign: 17722406278722554782
-> Nested Loop (cost=0.00..3420.05 rows=1921 width=0) (actual time=0.025..47.208 rows=10201 loops=1)
NodeSign: 17684322539419885852
-> Seq Scan on b (cost=0.00..1698.00 rows=96 width=6) (actual time=0.013..22.580 rows=101 loops=1)
NodeSign: 17065135700122418 8
Filter: (x = '1'::numeric)
Rows Removed by Filter: 99999
-> Materialize (cost=0.00..1698.10 rows=20 width=6) (actual time=0.000..0.235 rows=101 loops=101)
NodeSign: subordinate
-> Seq Scan on a (cost=0.00..1698.00 rows=20 width=6) (actual time=0.009..23.242 rows=101 loops=1)
NodeSign: 77779226766532752 21
Filter: (x = '1'::numeric)
Rows Removed by Filter: 99999
Planning Time: 0.146 ms
Execution Time: 47.942 ms
Replan Active: true
:

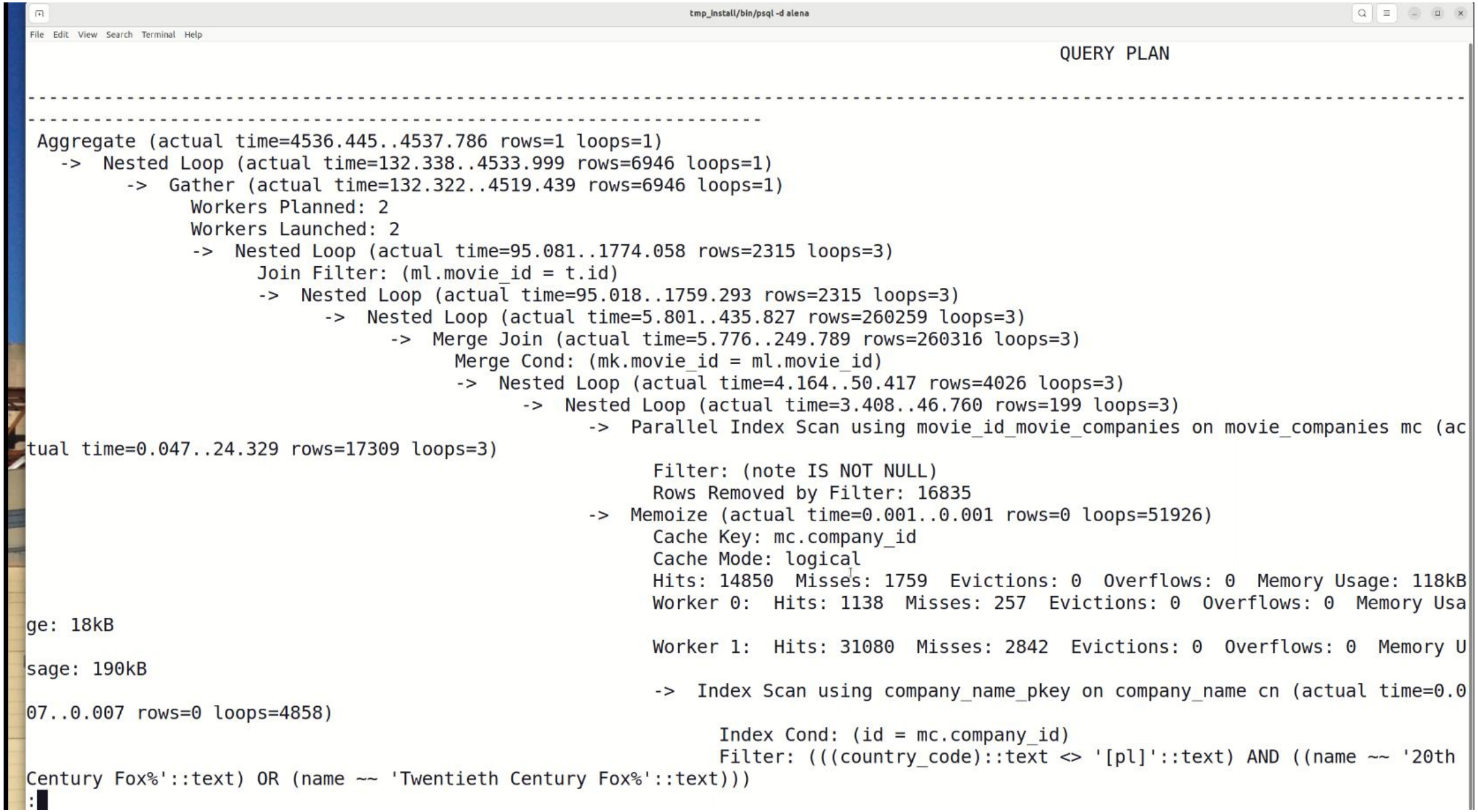

Query execution time
4
3.5
3
2.5
2
1.5
1
0.5
0
seconds
3.65
0.55
PostgreSQL Execution Time
Replan Total Execution Time
Attempts: 1
Timeout: 0.5 sec

```
FROM company_name AS cn,
     company_type AS ct,
     keyword AS k,
     link_type AS lt,
     movie_companies AS mc,
     movie_keyword AS mk,
     movie_link AS ml,
     title AS t
WHERE cn.country_code !='[pl]'
  AND (cn.name LIKE '20th Century Fox%'
       OR cn.name LIKE 'Twentieth Century Fox%')
  AND ct.kind != 'production companies'
  AND ct.kind IS NOT NULL
  AND k.keyword IN ('sequel',
                    'revenge',
                    'based-on-novel')
  AND mc.note IS NOT NULL
  AND t.production_year > 1950
  AND lt.id = ml.link_type_id
  AND ml.movie_id = t.id
  AND t.id = mk.movie_id
  AND mk.keyword_id = k.id
  AND t.id = mc.movie_id
  AND mc.company_type_id = ct.id
  AND mc.company_id = cn.id
  AND ml.movie_id = mk.movie_id
  AND ml.movie_id = mc.movie_id
  AND mk.movie_id = mc.movie_id;
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=#
```

tmp_install/bin/psql -d alena

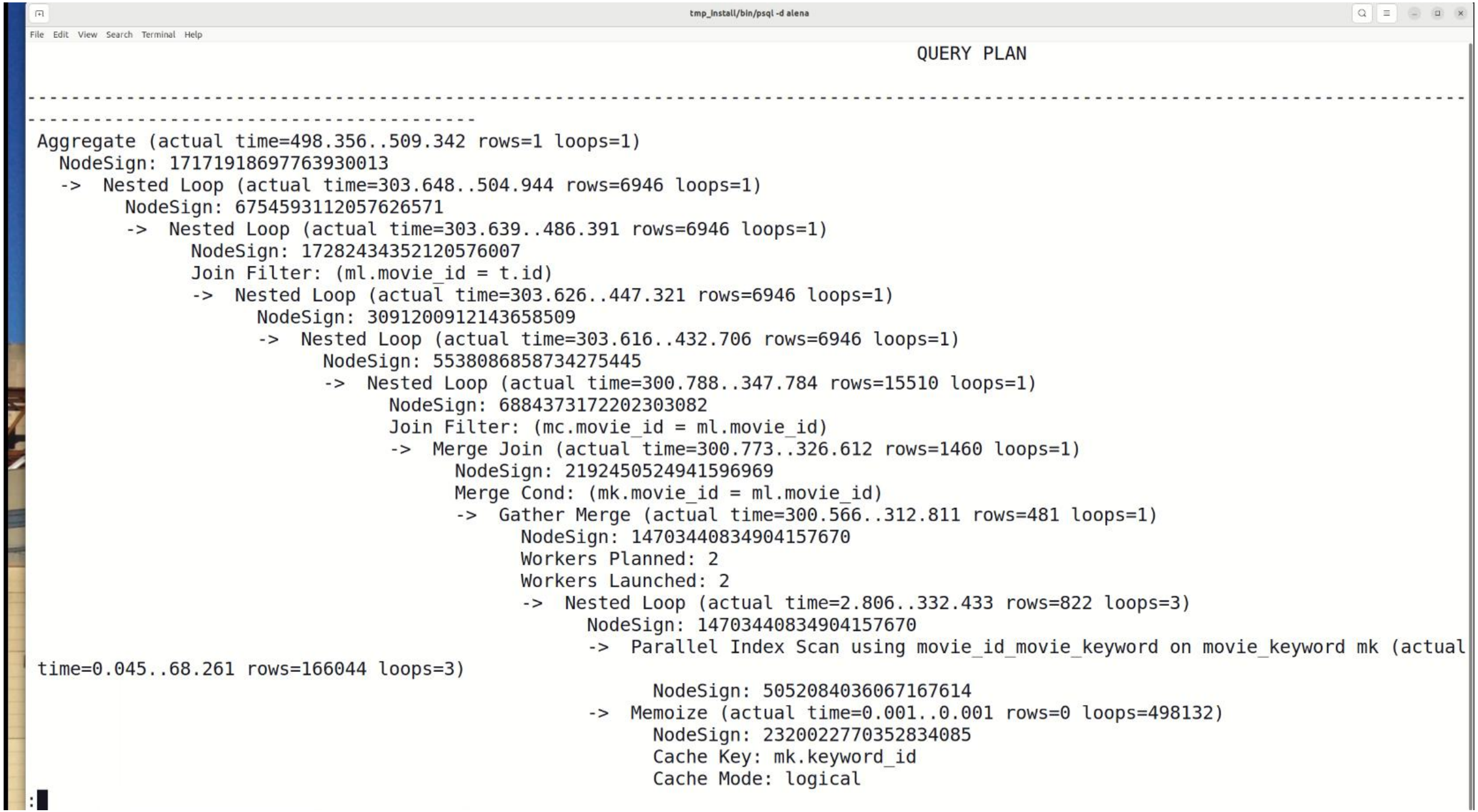
File Edit View Search Terminal Help

```
SET
SET
alena=# EXPLAIN (ANALYZE, COSTS OFF)
SELECT MIN(cn.name) AS from_company,
       MIN(mc.note) AS production_note,
       MIN(t.title) AS movie_based_on_book
FROM company_name AS cn,
     company_type AS ct,
     keyword AS k,
     link_type AS lt,
     movie_companies AS mc,
     movie_keyword AS mk,
     movie_link AS ml,
     title AS t
WHERE cn.country_code !='[pl]'
  AND (cn.name LIKE '20th Century Fox%'
       OR cn.name LIKE 'Twentieth Century Fox%')
  AND ct.kind != 'production companies'
  AND ct.kind IS NOT NULL
  AND k.keyword IN ('sequel',
                    'revenge',
                    'based-on-novel')
  AND mc.note IS NOT NULL
  AND t.production_year > 1950
  AND lt.id = ml.link_type_id
  AND ml.movie_id = t.id
  AND t.id = mk.movie_id
  AND mk.keyword_id = k.id
  AND t.id = mc.movie_id
  AND mc.company_type_id = ct.id
  AND mc.company_id = cn.id
  AND ml.movie_id = mk.movie_id
  AND ml.movie_id = mc.movie_id
  AND mk.movie_id = mc.movie_id;
```

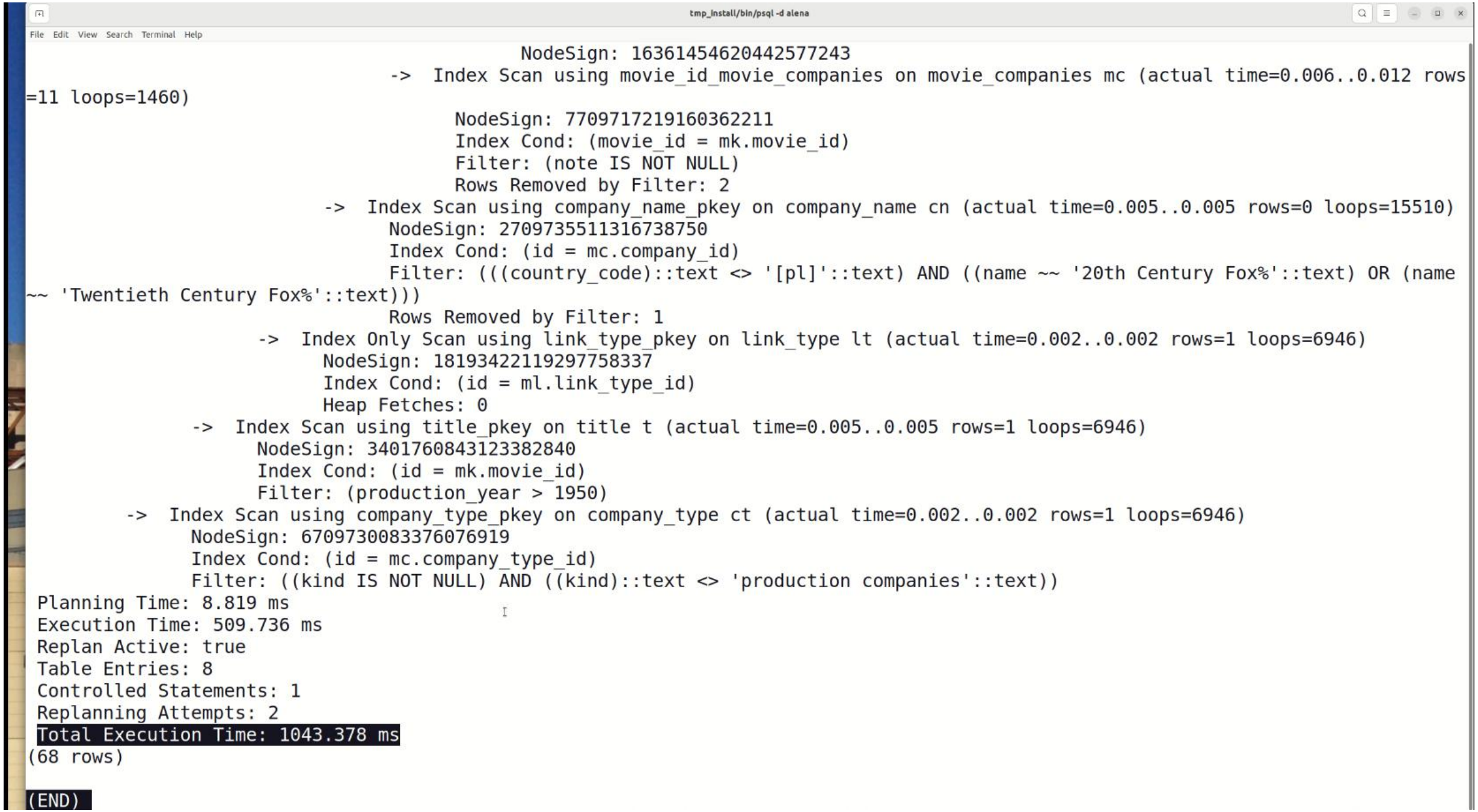

tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Aggregate (actual time=4536.445..4537.786 rows=1 loops=1)
-> Nested Loop (actual time=132.338..4533.999 rows=6946 loops=1)
-> Gather (actual time=132.322..4519.439 rows=6946 loops=1)
Workers Planned: 2
Workers Launched: 2
-> Nested Loop (actual time=95.081..1774.058 rows=2315 loops=3)
Join Filter: (ml.movie_id = t.id)
-> Nested Loop (actual time=95.018..1759.293 rows=2315 loops=3)
-> Nested Loop (actual time=5.801..435.827 rows=260259 loops=3)
-> Merge Join (actual time=5.776..249.789 rows=260316 loops=3)
Merge Cond: (mk.movie_id = ml.movie_id)
-> Nested Loop (actual time=4.164..50.417 rows=4026 loops=3)
-> Nested Loop (actual time=3.408..46.760 rows=199 loops=3)
-> Parallel Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.047..24.329 rows=17309 loops=3)
Filter: (note IS NOT NULL)
Rows Removed by Filter: 16835
-> Memoize (actual time=0.001..0.001 rows=0 loops=51926)
Cache Key: mc.company_id
Cache Mode: logical
Hits: 14850 Misses: 1759 Evictions: 0 Overflows: 0 Memory Usage: 118kB
Worker 0: Hits: 1138 Misses: 257 Evictions: 0 Overflows: 0 Memory Usage: 18kB
Worker 1: Hits: 31080 Misses: 2842 Evictions: 0 Overflows: 0 Memory Usage: 190kB
-> Index Scan using company_name_pkey on company_name cn (actual time=0.007..0.007 rows=0 loops=4858)
Index Cond: (id = mc.company_id)
Filter: (((country_code)::text <> '[pl]'::text) AND ((name ~~ '20th Century Fox%'::text) OR (name ~~ 'Twentieth Century Fox%'::text)))
:

```
                                                      Index Cond: (id = mc.company_id)
                                                      Filter: (((country_code)::text <> '[pl]'::text) AND ((name ~~ '20th
Century Fox%'::text) OR (name ~~ 'Twentieth Century Fox%'::text)))
                                                      Rows Removed by Filter: 1
                                           ->  Index Scan using movie_id_movie_keyword on movie_keyword mk (actual time=0.006..0.
013 rows=20 loops=598)
                                                 Index Cond: (movie_id = mc.movie_id)
                                     ->  Index Scan using movie_id_movie_link on movie_link ml (actual time=0.035..114.489 rows=2
89906 loops=3)
                               ->  Memoize (actual time=0.000..0.000 rows=1 loops=780947)
                                     Cache Key: mc.company_type_id
                                     Cache Mode: logical
                                     Hits: 61925  Misses: 2  Evictions: 0  Overflows: 0  Memory Usage: 1kB
                                     Worker 0:  Hits: 693055  Misses: 1  Evictions: 0  Overflows: 0  Memory Usage: 1kB
                                     Worker 1:  Hits: 25963  Misses: 1  Evictions: 0  Overflows: 0  Memory Usage: 1kB
                                     ->  Index Scan using company_type_pkey on company_type ct (actual time=0.015..0.016 rows=1 l
oops=4)
                                           Index Cond: (id = mc.company_type_id)
                                           Filter: ((kind IS NOT NULL) AND ((kind)::text <> 'production companies'::text))
                                           Rows Removed by Filter: 0
                         ->  Index Scan using keyword_pkey on keyword k (actual time=0.005..0.005 rows=0 loops=780776)
                               Index Cond: (id = mk.keyword_id)
                               Filter: (keyword = ANY ('{sequel,revenge,based-on-novel}'::text[]))
                               Rows Removed by Filter: 1
                   ->  Index Scan using title_pkey on title t (actual time=0.006..0.006 rows=1 loops=6946)
                         Index Cond: (id = mk.movie_id)
                         Filter: (production_year > 1950)
         ->  Index Only Scan using link_type_pkey on link_type lt (actual time=0.001..0.001 rows=1 loops=6946)
               Index Cond: (id = ml.link_type_id)
               Heap Fetches: 0
 Planning Time: 16.870 ms
 Execution Time: 4538.295 ms
(51 rows)

(END)
```

```
     keyword AS k,
     link_type AS lt,
     movie_companies AS mc,
     movie_keyword AS mk,
     movie_link AS ml,
     title AS t
WHERE cn.country_code !='[pl]'
  AND (cn.name LIKE '20th Century Fox%'
       OR cn.name LIKE 'Twentieth Century Fox%')
  AND ct.kind != 'production companies'
  AND ct.kind IS NOT NULL
  AND k.keyword IN ('sequel',
                    'revenge',
                    'based-on-novel')
  AND mc.note IS NOT NULL
  AND t.production_year > 1950
  AND lt.id = ml.link_type_id
  AND ml.movie_id = t.id
  AND t.id = mk.movie_id
  AND mk.keyword_id = k.id
  AND t.id = mc.movie_id
  AND mc.company_type_id = ct.id
  AND mc.company_id = cn.id
  AND ml.movie_id = mk.movie_id
  AND ml.movie_id = mc.movie_id
  AND mk.movie_id = mc.movie_id;
alena=# SET show_node_sign = 'on';
SET query_inadequate_execution_time = 200;
SET replan_max_attempts = 3;
SET show_node_sign = 'on';
SET
SET
SET
SET
alena=#
```


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Aggregate (actual time=498.356..509.342 rows=1 loops=1)
NodeSign: 17171918697763930013
-> Nested Loop (actual time=303.648..504.944 rows=6946 loops=1)
NodeSign: 6754593112057626571
-> Nested Loop (actual time=303.639..486.391 rows=6946 loops=1)
NodeSign: 17282434352120576007
Join Filter: (ml.movie_id = t.id)
-> Nested Loop (actual time=303.626..447.321 rows=6946 loops=1)
NodeSign: 3091200912143658509
-> Nested Loop (actual time=303.616..432.706 rows=6946 loops=1)
NodeSign: 5538086858734275445
-> Nested Loop (actual time=300.788..347.784 rows=15510 loops=1)
NodeSign: 6884373172202303082
Join Filter: (mc.movie_id = ml.movie_id)
-> Merge Join (actual time=300.773..326.612 rows=1460 loops=1)
NodeSign: 2192450524941596969
Merge Cond: (mk.movie_id = ml.movie_id)
-> Gather Merge (actual time=300.566..312.811 rows=481 loops=1)
NodeSign: 14703440834904157670
Workers Planned: 2
Workers Launched: 2
-> Nested Loop (actual time=2.806..332.433 rows=822 loops=3)
NodeSign: 14703440834904157670
-> Parallel Index Scan using movie_id_movie_keyword on movie_keyword mk (actual time=0.045..68.261 rows=166044 loops=3)
NodeSign: 5052084036067167614
-> Memoize (actual time=0.001..0.001 rows=0 loops=498132)
NodeSign: 2320022770352834085
Cache Key: mk.keyword_id
Cache Mode: logical
:

```
                                        NodeSign: 16361454620442577243
                                  ->  Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.006..0.012 rows
=11 loops=1460)
                                        NodeSign: 7709717219160362211
                                        Index Cond: (movie_id = mk.movie_id)
                                        Filter: (note IS NOT NULL)
                                        Rows Removed by Filter: 2
                               ->  Index Scan using company_name_pkey on company_name cn (actual time=0.005..0.005 rows=0 loops=15510)
                                     NodeSign: 2709735511316738750
                                     Index Cond: (id = mc.company_id)
                                     Filter: (((country_code)::text <> '[pl]'::text) AND ((name ~~ '20th Century Fox%'::text) OR (name
~~ 'Twentieth Century Fox%'::text)))
                                     Rows Removed by Filter: 1
                           ->  Index Only Scan using link_type_pkey on link_type lt (actual time=0.002..0.002 rows=1 loops=6946)
                                 NodeSign: 18193422119297758337
                                 Index Cond: (id = ml.link_type_id)
                                 Heap Fetches: 0
                     ->  Index Scan using title_pkey on title t (actual time=0.005..0.005 rows=1 loops=6946)
                           NodeSign: 3401760843123382840
                           Index Cond: (id = mk.movie_id)
                           Filter: (production_year > 1950)
               ->  Index Scan using company_type_pkey on company_type ct (actual time=0.002..0.002 rows=1 loops=6946)
                     NodeSign: 6709730083376076919
                     Index Cond: (id = mc.company_type_id)
                     Filter: ((kind IS NOT NULL) AND ((kind)::text <> 'production companies'::text))
 Planning Time: 8.819 ms
 Execution Time: 509.736 ms
 Replan Active: true
 Table Entries: 8
 Controlled Statements: 1
 Replanning Attempts: 2
 Total Execution Time: 1043.378 ms
(68 rows)

(END)
```


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
NodeSign: 16361454620442577243
-> Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.006..0.012 rows=11 loops=1460)
NodeSign: 7709717219160362211
Index Cond: (movie_id = mk.movie_id)
Filter: (note IS NOT NULL)
Rows Removed by Filter: 2
-> Index Scan using company_name_pkey on company_name cn (actual time=0.005..0.005 rows=0 loops=15510)
NodeSign: 2709735511316738750
Index Cond: (id = mc.company_id)
Filter: (((country_code)::text <> '[pl]'::text) AND ((name ~~ '20th Century Fox%'::text) OR (name ~~ 'Twentieth Century Fox%'::text)))
Rows Removed by Filter: 1
-> Index Only Scan using link_type_pkey on link_type lt (actual time=0.002..0.002 rows=1 loops=6946)
NodeSign: 18193422119297758337
Index Cond: (id = ml.link_type_id)
Heap Fetches: 0
-> Index Scan using title_pkey on title t (actual time=0.005..0.005 rows=1 loops=6946)
NodeSign: 3401760843123382840
Index Cond: (id = mk.movie_id)
Filter: (production_year > 1950)
-> Index Scan using company_type_pkey on company_type ct (actual time=0.002..0.002 rows=1 loops=6946)
NodeSign: 6709730083376076919
Index Cond: (id = mc.company_type_id)
Filter: ((kind IS NOT NULL) AND ((kind)::text <> 'production companies'::text))
Planning Time: 8.819 ms
Execution Time: 509.736 ms
Replan Active: true
Table Entries: 8
Controlled Statements: 1
Replanning Attempts: 2
Total Execution Time: 1043.378 ms
(68 rows)
(END)


Query execution time 11c
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
seconds
4.28
1.01
PostgreSQL Execution Time
Replan Total Execution Time
Attempts: 2
Timeout: 0.2 sec

```
    char_name AS chn,
    cast_info AS ci,
    company_name AS cn,
    info_type AS it,
    info_type AS it3,
    keyword AS k,
    movie_companies AS mc,
    movie_info AS mi,
    movie_keyword AS mk,
    name AS n,
    person_info AS pi,
    role_type AS rt,
    title AS t
WHERE cct1.kind ='cast'
  AND cct2.kind ='complete+verified'
  AND ci.note IN ('(voice)',
                  '(voice: Japanese version)',
                  '(voice) (uncredited)',
  AND cct2.id = cc.status_id;d_id000 AND 2010
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=#
```

```
       MIN(mi_idx.info) AS rating,
       MIN(t.title) AS complete_hero_movie
FROM complete_cast AS cc,
     comp_cast_type AS cct1,
     comp_cast_type AS cct2,
     char_name AS chn,
     cast_info AS ci,
     info_type AS it2,
     keyword AS k,
     kind_type AS kt,
     movie_info_idx AS mi_idx,
     movie_keyword AS mk,
     name AS n,
     title AS t
WHERE cct1.kind = 'cast'
  AND cct2.kind LIKE '%complete%'
  AND chn.name IS NOT NULL
  AND (chn.name LIKE '%man%'
       OR chn.name LIKE '%Man%')
  AND it2.info = 'rating'
  AND k.keyword IN ('superhero',
                    'marvel-comics',
                    'based-on-comic',
                    'tv-special',
  AND it2.id = mi_idx.info_type_id;
```

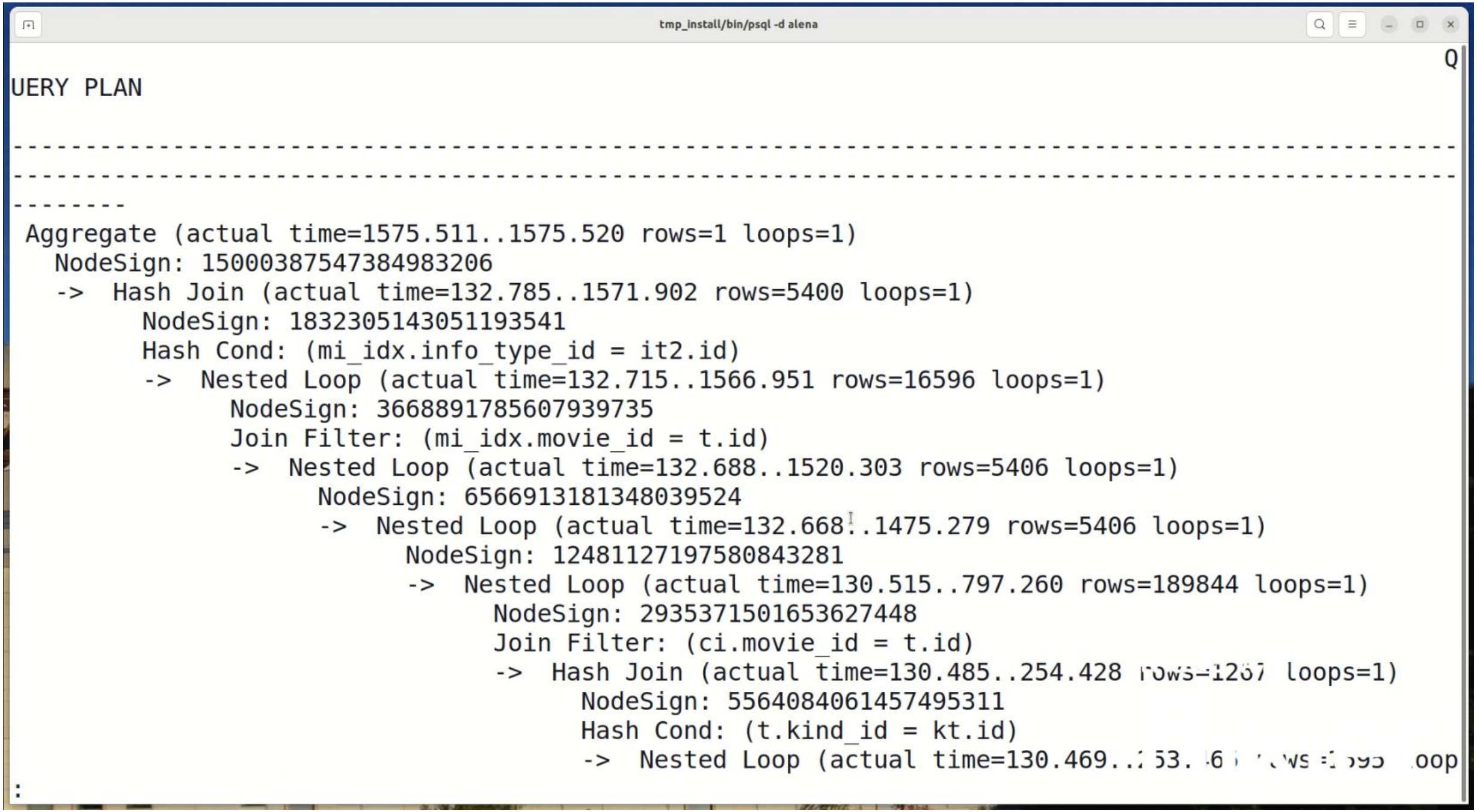
tmp_install/bin/psql -d alena

```
QUERY PLAN
-----------------------------------------------------------------------------------------------------
 Aggregate (actual time=258021.132..258021.140 rows=1 loops=1)
   ->  Nested Loop (actual time=386.815..258009.527 rows=5400 loops=1)
         ->  Nested Loop (actual time=1.042..256240.244 rows=189738 loops=1)
               ->  Nested Loop (actual time=0.322..37660.250 rows=41119579 loops=1)
                     ->  Nested Loop (actual time=0.298..11614.031 rows=385916 loops=1)
                           ->  Nested Loop (actual time=0.282..8378.097 rows=385916 loops=1)
                                 ->  Nested Loop (actual time=0.257..1936.360 rows=4028 loops=1)
                                       Join Filter: (kt.id = t.kind_id)
                                       Rows Removed by Join Filter: 8908
                                       ->  Seq Scan on kind_type kt (actual time=0.029..0.033 rows=1 loops=1)
                                             Filter: ((kind)::text = 'movie'::text)
                                             Rows Removed by Filter: 6
                                       ->  Nested Loop (actual time=0.227..1931.584 rows=12936 loops=1)
                                             Join Filter: (cc.movie_id = t.id)
                                             ->  Hash Join (actual time=0.104..903.636 rows=61559 loops=1)
                                                   Hash Cond: (mi_idx.info_type_id = it2.id)
                                                   ->  Nested Loop (actual time=0.070..[illegible] rows=184902 loops=1)
:
```

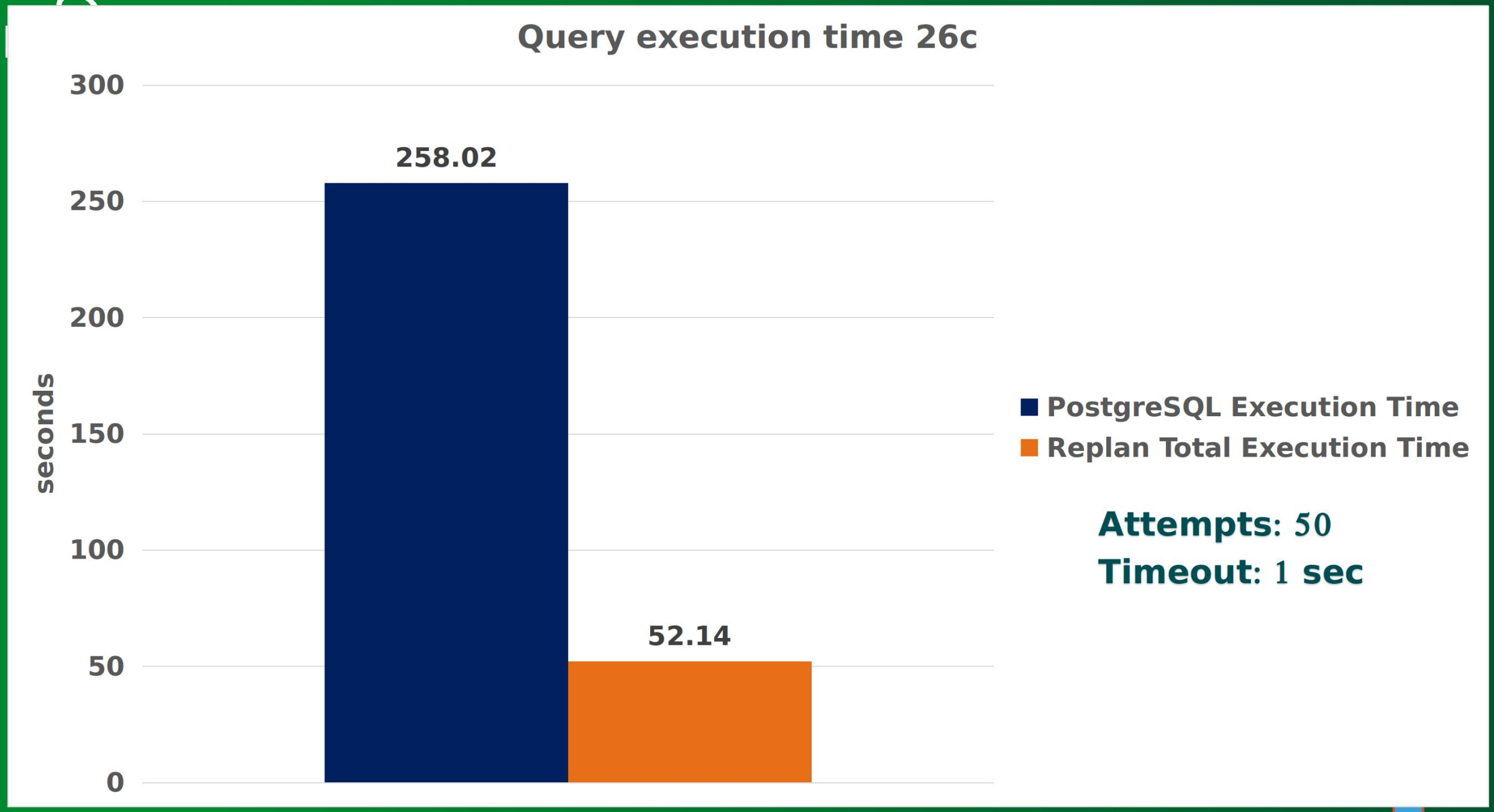
```
me=0.191..1.567 rows=96 loops=4028)
                                        Index Cond: (movie_id = t.id)
                                ->  Index Only Scan using name_pkey on name n (actual time=0.008..0.008
rows=1 loops=385916)
                                      Index Cond: (id = ci.person_id)
                                      Heap Fetches: 0
                            ->  Index Scan using movie_id_movie_keyword on movie_keyword mk (actual time=0
.008..0.047 rows=107 loops=385916)
                                  Index Cond: (movie_id = t.id)
                      ->  Index Scan using keyword_pkey on keyword k (actual time=0.005..0.005 rows=0 loop
s=41119579)
                            Index Cond: (id = mk.keyword_id)
                            Filter: (keyword = ANY ('{superhero,marvel-comics,based-on-comic,tv-special,fi
ght,violence,magnet,web,claw,laser}'::text[]))
                            Rows Removed by Filter: 1
                ->  Index Scan using char_name_pkey on char_name chn (actual time=0.009..0.009 rows=0 loop
s=189738)
                      Index Cond: (id = ci.person_role_id)
                      Filter: ((name IS NOT NULL) AND ((name ~~ '%man%'::text) OR (name ~~ '%Man%'::text))
)
                      Rows Removed by Filter: 0
 Planning Time: 180.249 ms
 Execution Time: 258021.306 ms
(60 rows)

(END)
```

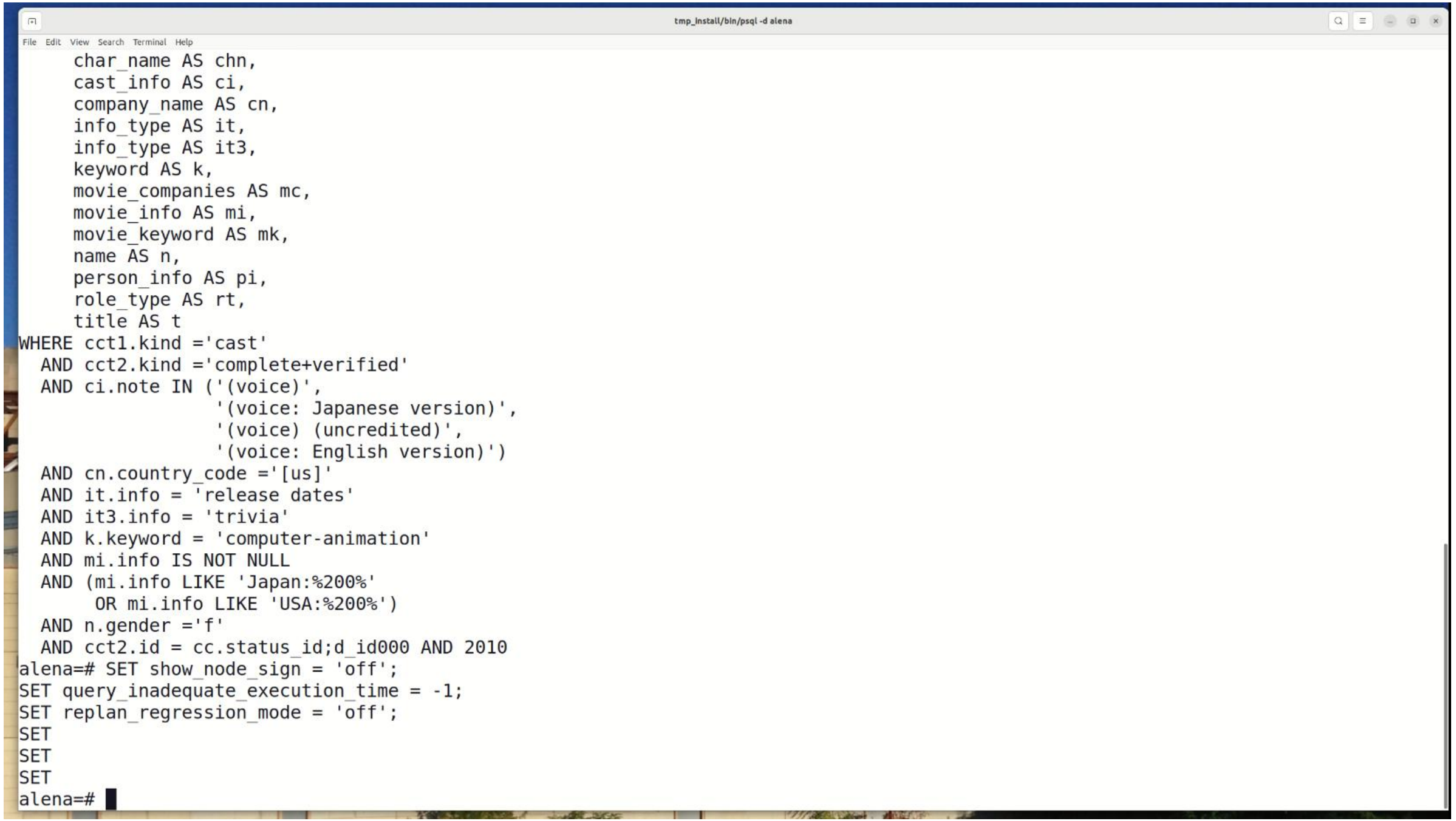
```
    comp_cast_type AS cct1,
    comp_cast_type AS cct2,
    char_name AS chn,
    cast_info AS ci,
    info_type AS it2,
    keyword AS k,
    kind_type AS kt,
    movie_info_idx AS mi_idx,
    movie_keyword AS mk,
    name AS n,
    title AS t
WHERE cct1.kind = 'cast'
  AND cct2.kind LIKE '%complete%'
  AND chn.name IS NOT NULL
  AND (chn.name LIKE '%man%'
       OR chn.name LIKE '%Man%')
  AND it2.info = 'rating'
  AND k.keyword IN ('superhero',
                    'marvel-comics',
                    'based-on-comic',
                    'tv-special',
  AND it2.id = mi_idx.info_type_id;
alena=# SET show_node_sign = 'on';
SET query_inadequate_execution_time = 1000;
SET replan_max_attempts = 49;
SET show_node_sign = 'on';
```

```
       MIN(mi_idx.info) AS rating,
       MIN(t.title) AS complete_hero_movie
FROM complete_cast AS cc,
     comp_cast_type AS cct1,
     comp_cast_type AS cct2,
     char_name AS chn,
     cast_info AS ci,
     info_type AS it2,
     keyword AS k,
     kind_type AS kt,
     movie_info_idx AS mi_idx,
     movie_keyword AS mk,
     name AS n,
     title AS t
WHERE cct1.kind = 'cast'
  AND cct2.kind LIKE '%complete%'
  AND chn.name IS NOT NULL
  AND (chn.name LIKE '%man%'
       OR chn.name LIKE '%Man%')
  AND it2.info = 'rating'
  AND k.keyword IN ('superhero',
                    'marvel-comics',
                    'based-on-comic',
                    'tv-special',
  AND it2.id = mi_idx.info_type_id;
```

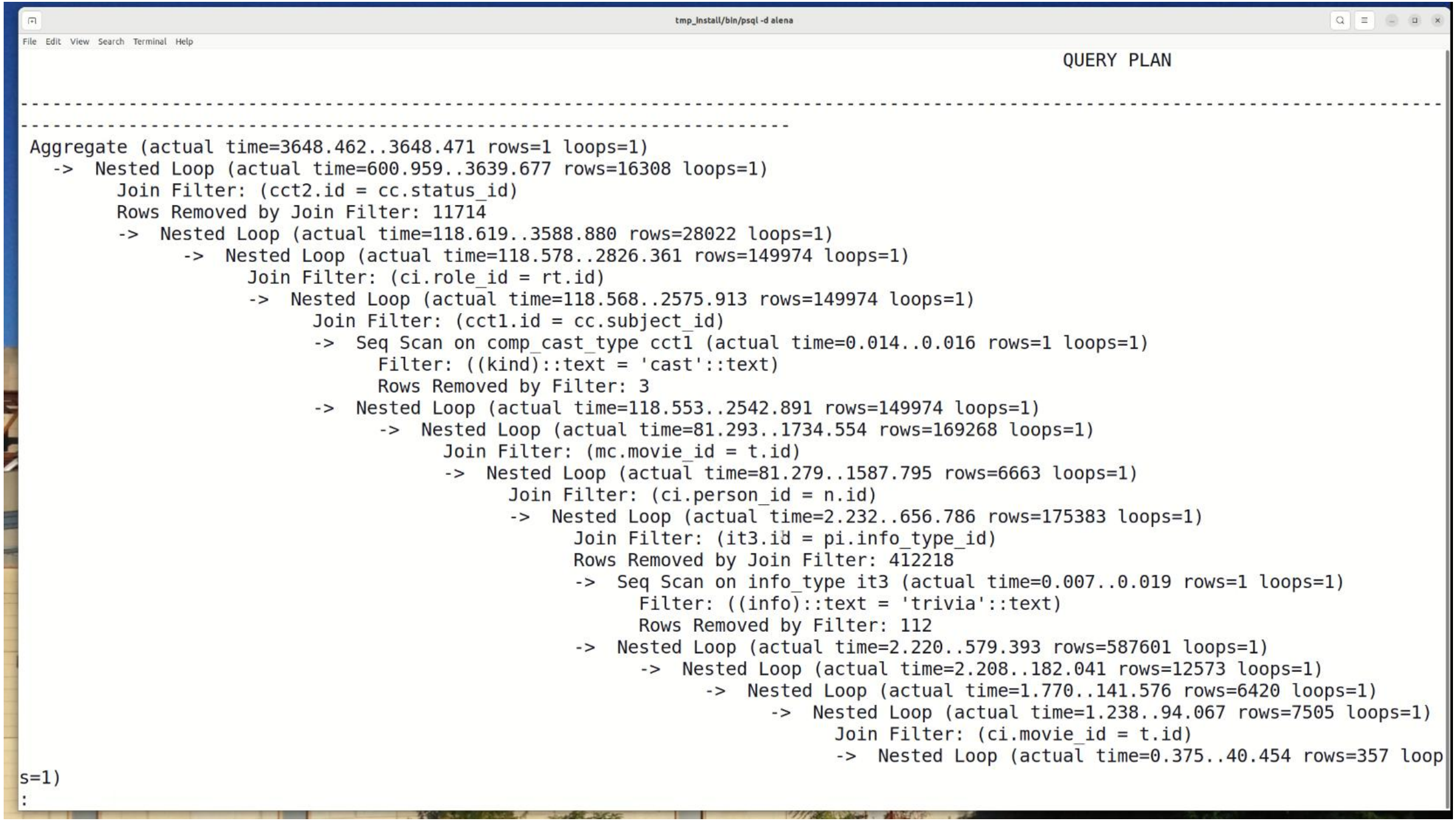

tmp_install/bin/psql -d alena
Q
UERY PLAN
Aggregate (actual time=1575.511..1575.520 rows=1 loops=1)
NodeSign: 1500038754738498320 6
-> Hash Join (actual time=132.785..1571.902 rows=5400 loops=1)
NodeSign: 18323051430511935 41
Hash Cond: (mi_idx.info_type_id = it2.id)
-> Nested Loop (actual time=132.715..1566.951 rows=16596 loops=1)
NodeSign: 3668891785607939735
Join Filter: (mi_idx.movie_id = t.id)
-> Nested Loop (actual time=132.688..1520.303 rows=5406 loops=1)
NodeSign: 6566913181348039524
-> Nested Loop (actual time=132.668..1475.279 rows=5406 loops=1)
NodeSign: 12481127197580843281
-> Nested Loop (actual time=130.515..797.260 rows=189844 loops=1)
NodeSign: 29353715016536274 48
Join Filter: (ci.movie_id = t.id)
-> Hash Join (actual time=130.485..254.428 rows=1267 loops=1)
NodeSign: 5564084061457495311
Hash Cond: (t.kind_id = kt.id)
-> Nested Loop (actual time=130.469..253.6 rows=1995 loop
:

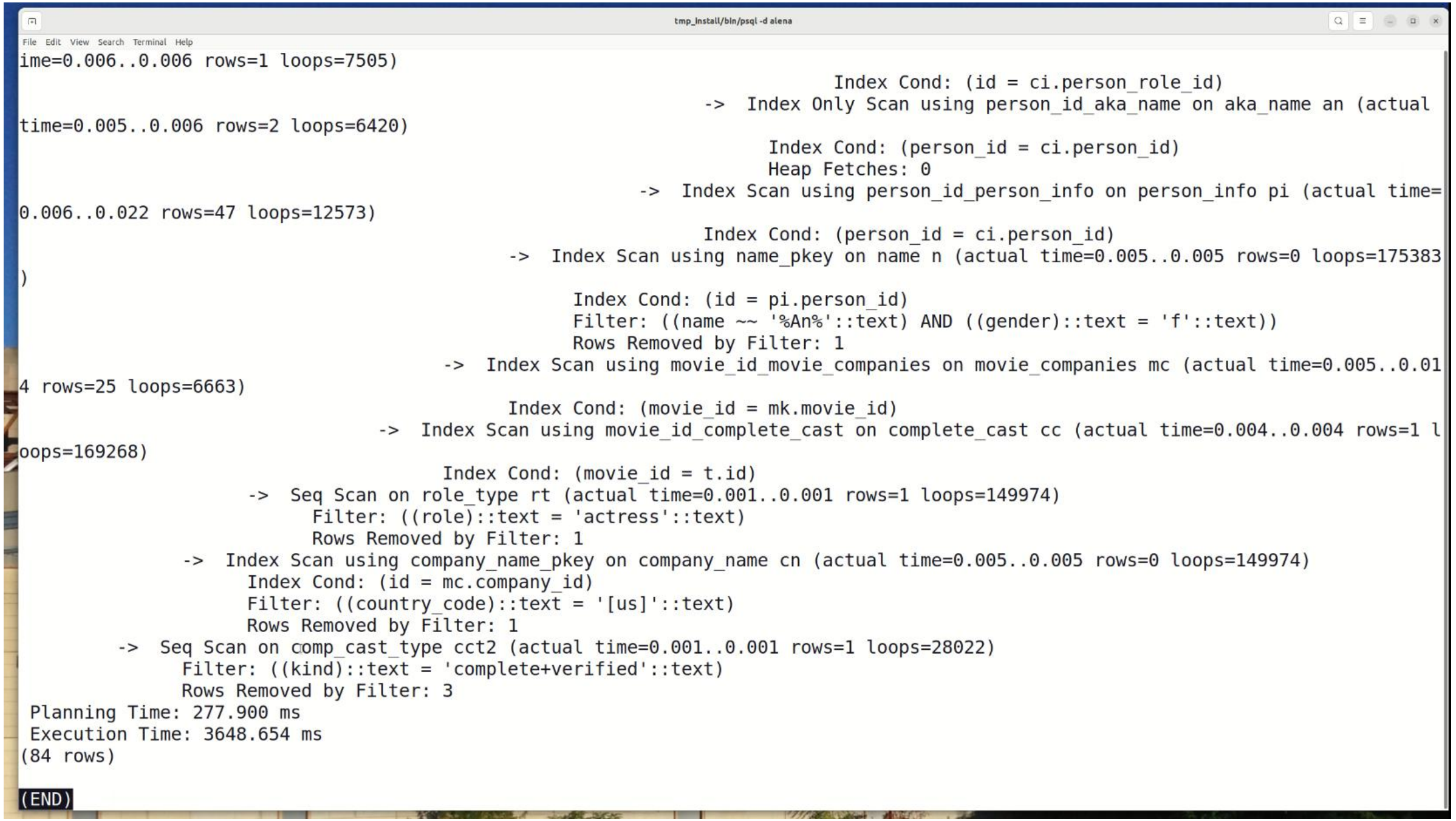
```
                    ->  Index Only Scan using name_pkey on name n (actual time=0.008..0.008 rows=1
 loops=5406)
                          NodeSign: 11336545220415608477
                          Index Cond: (id = ci.person_id)
                          Heap Fetches: 0
                ->  Index Scan using movie_id_movie_info_idx on movie_info_idx mi_idx (actual time=0
.006..0.007 rows=3 loops=5406)
                      NodeSign: 45745949002554502 71
                      Index Cond: (movie_id = ci.movie_id)
          ->  Hash (actual time=0.059..0.060 rows=1 loops=1)
                NodeSign: 10579708320778064610
                Buckets: 1024  Batches: 1  Memory Usage: 9kB
                ->  Seq Scan on info_type it2 (actual time=0.052..0.054 rows=1 loops=1)
                      NodeSign: 10579708320778064610
                      Filter: ((info)::text = 'rating'::text)
                      Rows Removed by Filter: 112
 Planning Time: 256.081 ms
 Execution Time: 1575.765 ms
 Replan Active: true
 Table Entries: 12
 Controlled Statements: 1
 Replanning Attempts: 50
 Total Execution Time: 52143.726 ms
(102 rows)

(END)
```


Query execution time 26c
300
250
200
150
100
50
0
seconds
258.02
52.14
PostgreSQL Execution Time
Replan Total Execution Time
Attempts: 50
Timeout: 1 sec


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
char_name AS chn,
cast_info AS ci,
company_name AS cn,
info_type AS it,
info_type AS it3,
keyword AS k,
movie_companies AS mc,
movie_info AS mi,
movie_keyword AS mk,
name AS n,
person_info AS pi,
role_type AS rt,
title AS t
WHERE cct1.kind ='cast'
AND cct2.kind ='complete+verified'
AND ci.note IN ('(voice)',
'(voice: Japanese version)',
'(voice) (uncredited)',
'(voice: English version)')
AND cn.country_code ='[us]'
AND it.info = 'release dates'
AND it3.info = 'trivia'
AND k.keyword = 'computer-animation'
AND mi.info IS NOT NULL
AND (mi.info LIKE 'Japan:%200%'
OR mi.info LIKE 'USA:%200%')
AND n.gender ='f'
AND cct2.id = cc.status_id;d_id000 AND 2010
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=#

```
       MIN(n.name) AS voicing_actress,
       MIN(t.title) AS voiced_animation
FROM aka_name AS an,
     complete_cast AS cc,
     comp_cast_type AS cct1,
     comp_cast_type AS cct2,
     char_name AS chn,
     cast_info AS ci,
     company_name AS cn,
     info_type AS it,
     info_type AS it3,
     keyword AS k,
     movie_companies AS mc,
     movie_info AS mi,
     movie_keyword AS mk,
     name AS n,
     person_info AS pi,
     role_type AS rt,
     title AS t
WHERE cct1.kind ='cast'
  AND cct2.kind ='complete+verified'
  AND ci.note IN ('(voice)',
                  '(voice: Japanese version)',
                  '(voice) (uncredited)',
                  '(voice: English version)')
  AND cn.country_code ='[us]'
  AND it.info = 'release dates'
  AND it3.info = 'trivia'
  AND k.keyword = 'computer-animation'
  AND mi.info IS NOT NULL
  AND (mi.info LIKE 'Japan:%200%'
       OR mi.info LIKE 'USA:%200%')
  AND n.gender ='f'
  AND cct2.id = cc.status_id;d_id000 AND 2010
```

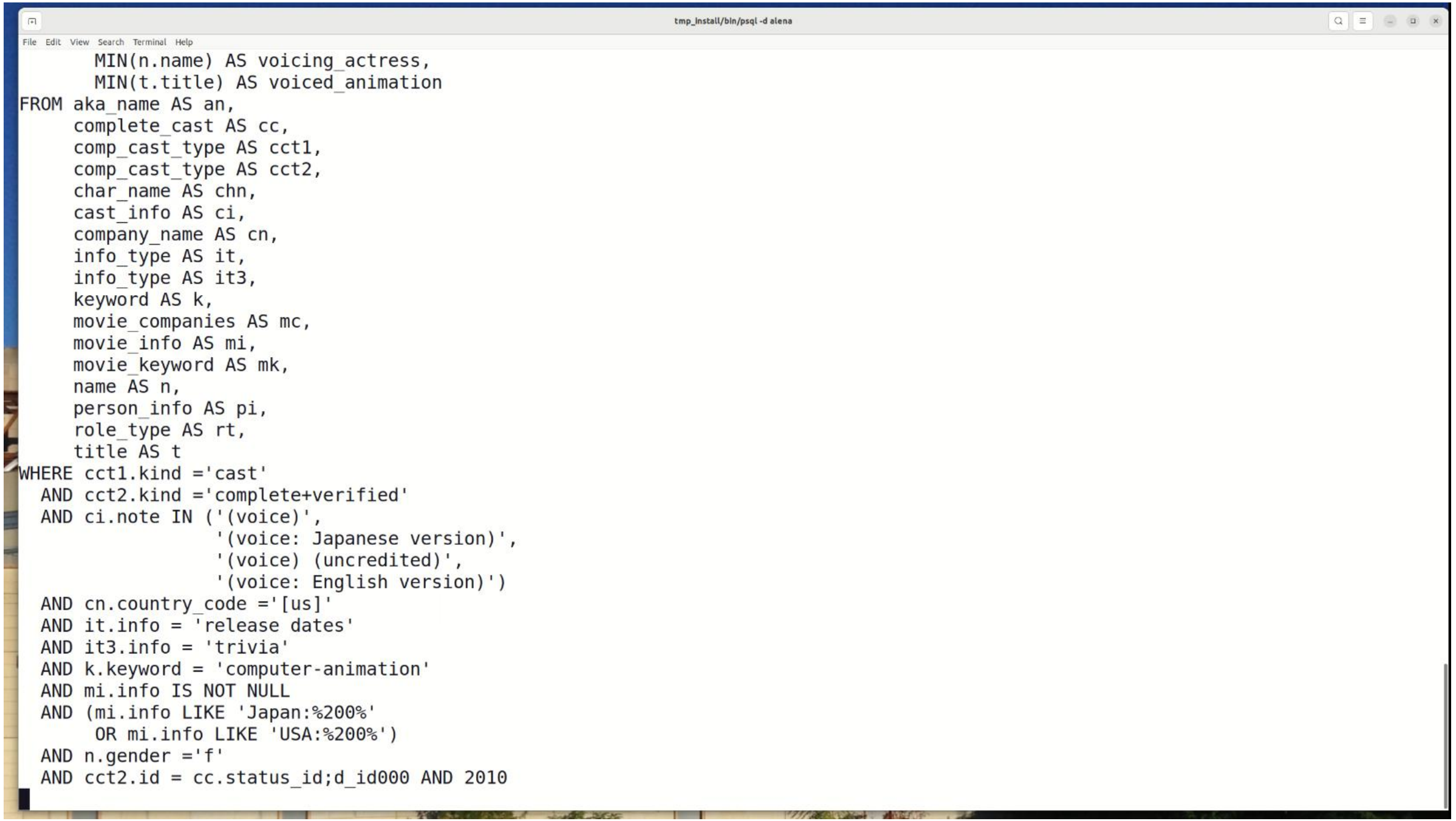

tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Aggregate (actual time=3648.462..3648.471 rows=1 loops=1)
-> Nested Loop (actual time=600.959..3639.677 rows=16308 loops=1)
Join Filter: (cct2.id = cc.status_id)
Rows Removed by Join Filter: 11714
-> Nested Loop (actual time=118.619..3588.880 rows=28022 loops=1)
-> Nested Loop (actual time=118.578..2826.361 rows=149974 loops=1)
Join Filter: (ci.role_id = rt.id)
-> Nested Loop (actual time=118.568..2575.913 rows=149974 loops=1)
Join Filter: (cct1.id = cc.subject_id)
-> Seq Scan on comp_cast_type cct1 (actual time=0.014..0.016 rows=1 loops=1)
Filter: ((kind)::text = 'cast'::text)
Rows Removed by Filter: 3
-> Nested Loop (actual time=118.553..2542.891 rows=149974 loops=1)
-> Nested Loop (actual time=81.293..1734.554 rows=169268 loops=1)
Join Filter: (mc.movie_id = t.id)
-> Nested Loop (actual time=81.279..1587.795 rows=6663 loops=1)
Join Filter: (ci.person_id = n.id)
-> Nested Loop (actual time=2.232..656.786 rows=175383 loops=1)
Join Filter: (it3.id = pi.info_type_id)
Rows Removed by Join Filter: 412218
-> Seq Scan on info_type it3 (actual time=0.007..0.019 rows=1 loops=1)
Filter: ((info)::text = 'trivia'::text)
Rows Removed by Filter: 112
-> Nested Loop (actual time=2.220..579.393 rows=587601 loops=1)
-> Nested Loop (actual time=2.208..182.041 rows=12573 loops=1)
-> Nested Loop (actual time=1.770..141.576 rows=6420 loops=1)
-> Nested Loop (actual time=1.238..94.067 rows=7505 loops=1)
Join Filter: (ci.movie_id = t.id)
-> Nested Loop (actual time=0.375..40.454 rows=357 loop
s=1)
:

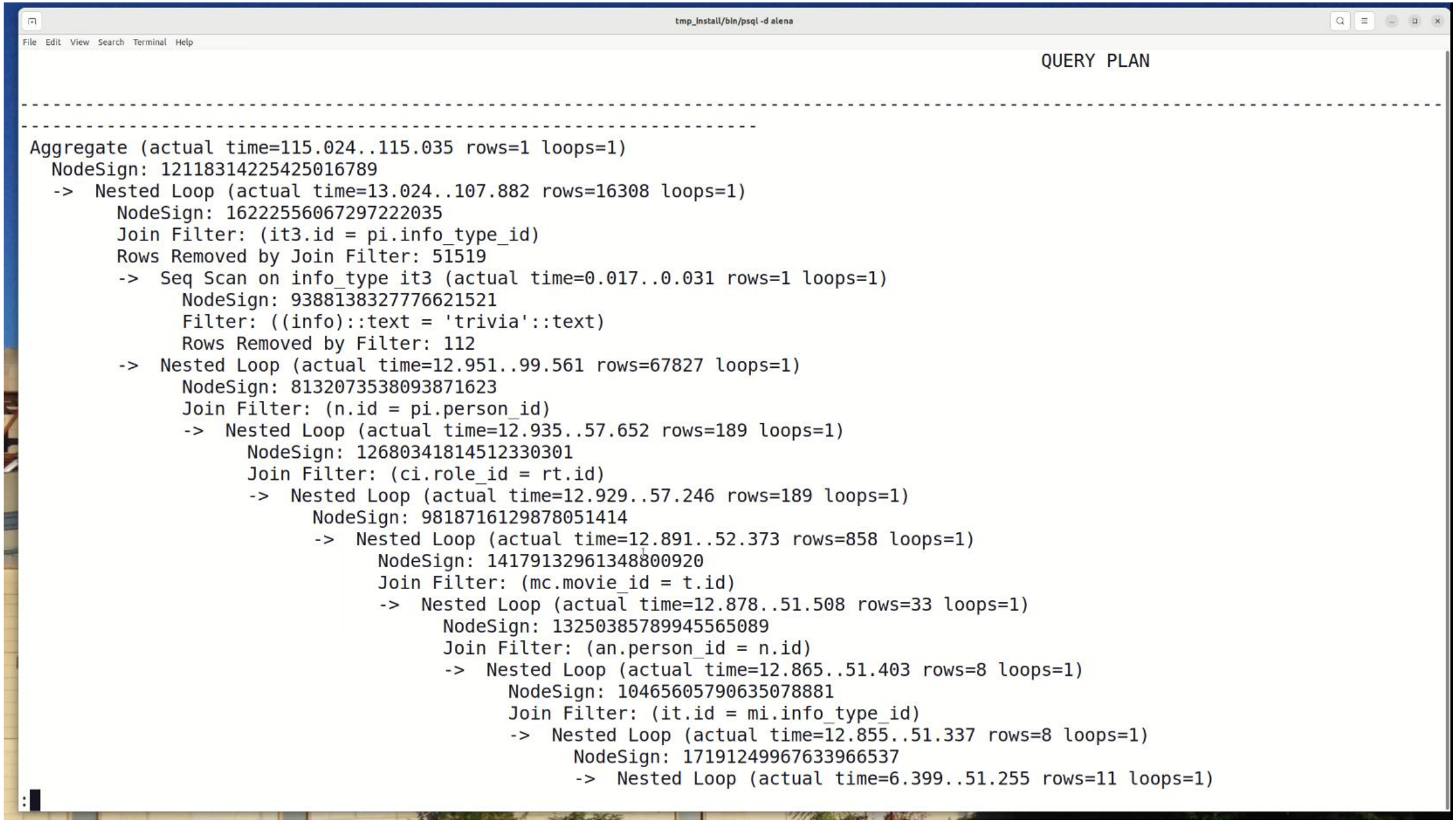

tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
ime=0.006..0.006 rows=1 loops=7505)
Index Cond: (id = ci.person_role_id)
-> Index Only Scan using person_id_aka_name on aka_name an (actual
time=0.005..0.006 rows=2 loops=6420)
Index Cond: (person_id = ci.person_id)
Heap Fetches: 0
-> Index Scan using person_id_person_info on person_info pi (actual time=
0.006..0.022 rows=47 loops=12573)
Index Cond: (person_id = ci.person_id)
-> Index Scan using name_pkey on name n (actual time=0.005..0.005 rows=0 loops=175383
)
Index Cond: (id = pi.person_id)
Filter: ((name ~~ '%An%'::text) AND ((gender)::text = 'f'::text))
Rows Removed by Filter: 1
-> Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.005..0.01
4 rows=25 loops=6663)
Index Cond: (movie_id = mk.movie_id)
-> Index Scan using movie_id_complete_cast on complete_cast cc (actual time=0.004..0.004 rows=1 l
oops=169268)
Index Cond: (movie_id = t.id)
-> Seq Scan on role_type rt (actual time=0.001..0.001 rows=1 loops=149974)
Filter: ((role)::text = 'actress'::text)
Rows Removed by Filter: 1
-> Index Scan using company_name_pkey on company_name cn (actual time=0.005..0.005 rows=0 loops=149974)
Index Cond: (id = mc.company_id)
Filter: ((country_code)::text = '[us]'::text)
Rows Removed by Filter: 1
-> Seq Scan on comp_cast_type cct2 (actual time=0.001..0.001 rows=1 loops=28022)
Filter: ((kind)::text = 'complete+verified'::text)
Rows Removed by Filter: 3
Planning Time: 277.900 ms
Execution Time: 3648.654 ms
(84 rows)
(END)

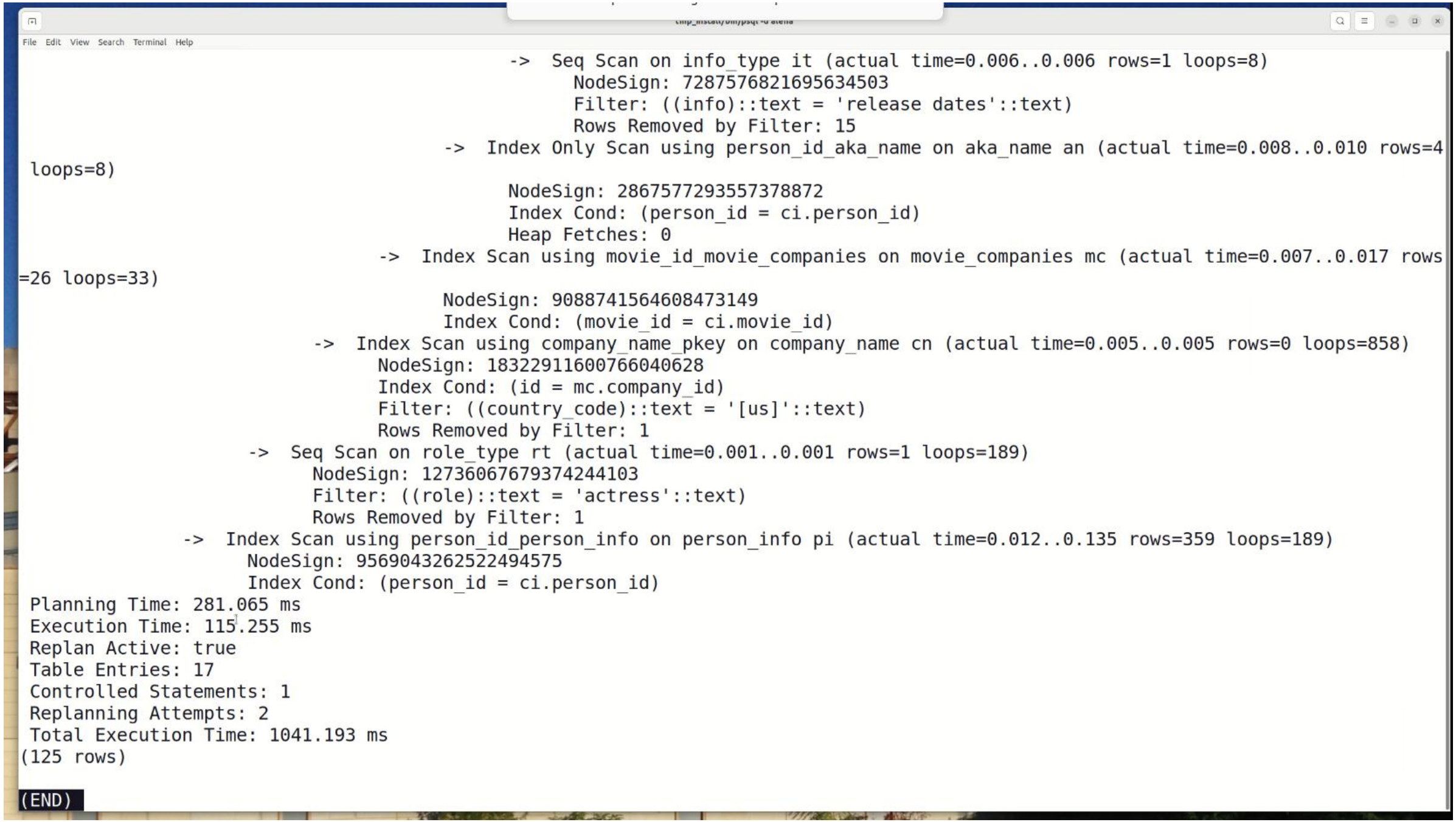
tmp_install/bin/psql -d alena

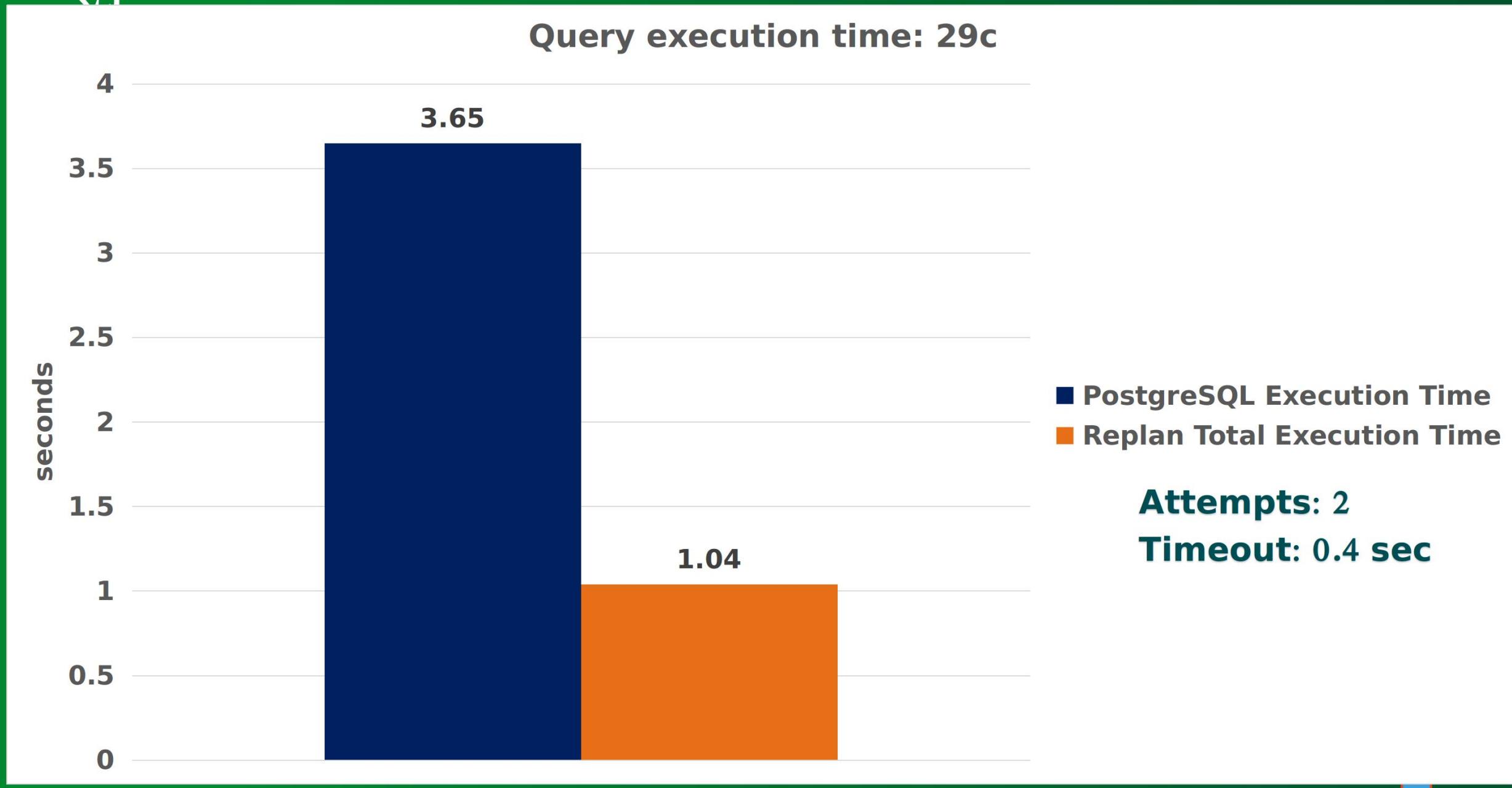
File Edit View Search Terminal Help

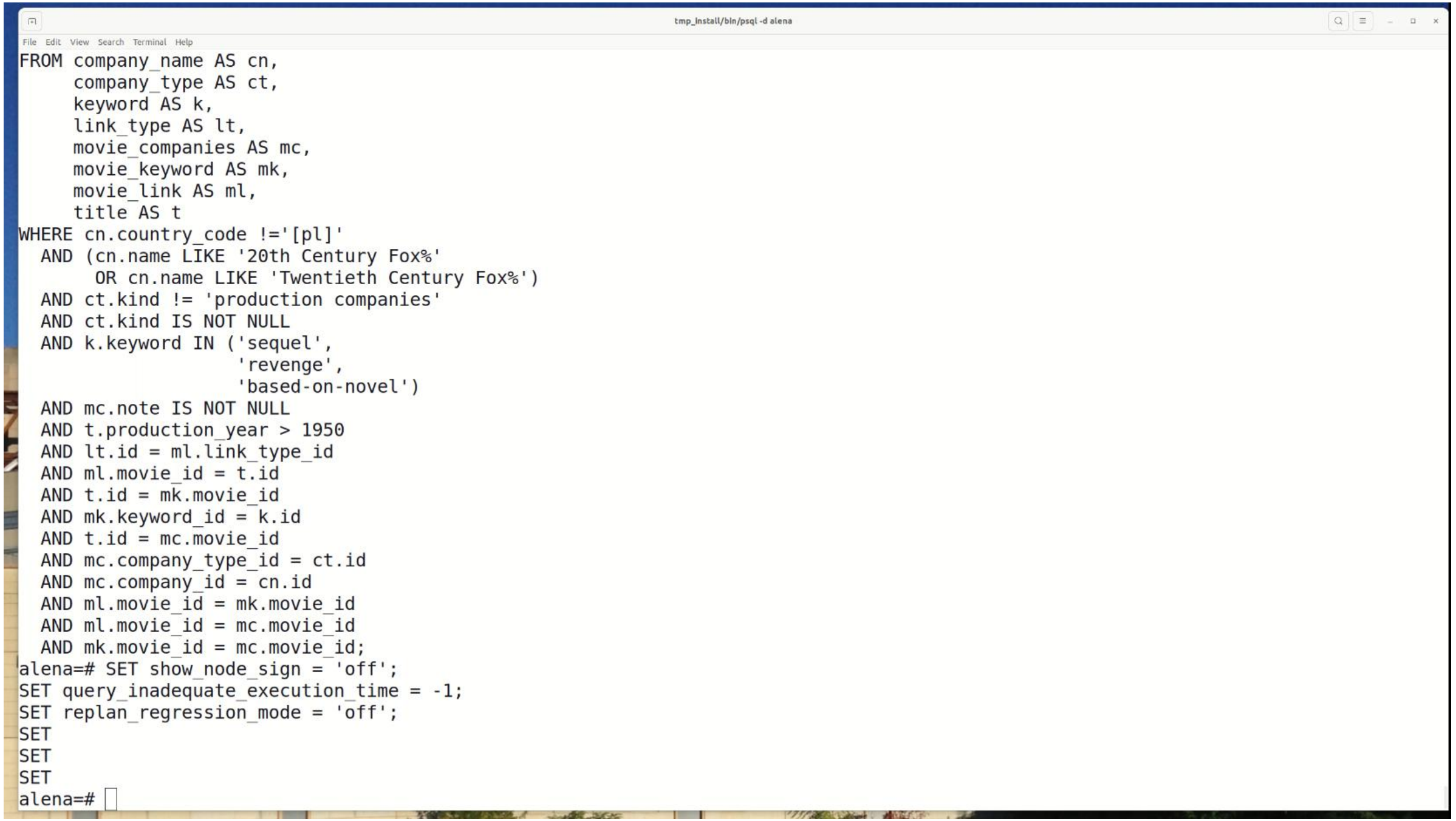
```
     company_name AS cn,
     info_type AS it,
     info_type AS it3,
     keyword AS k,
     movie_companies AS mc,
     movie_info AS mi,
     movie_keyword AS mk,
     name AS n,
     person_info AS pi,
     role_type AS rt,
     title AS t
WHERE cct1.kind ='cast'
  AND cct2.kind ='complete+verified'
  AND ci.note IN ('(voice)',
                  '(voice: Japanese version)',
                  '(voice) (uncredited)',
                  '(voice: English version)')
  AND cn.country_code ='[us]'
  AND it.info = 'release dates'
  AND it3.info = 'trivia'
  AND k.keyword = 'computer-animation'
  AND mi.info IS NOT NULL
  AND (mi.info LIKE 'Japan:%200%'
       OR mi.info LIKE 'USA:%200%')
  AND n.gender ='f'
  AND cct2.id = cc.status_id;d_id000 AND 2010
alena=# SET show_node_sign = 'on';
SET query_inadequate_execution_time = 400;
SET replan_max_attempts = 8;
SET show_node_sign = 'on';
SET
SET
SET
SET
alena=#
```


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
MIN(n.name) AS voicing_actress,
MIN(t.title) AS voiced_animation
FROM aka_name AS an,
complete_cast AS cc,
comp_cast_type AS cct1,
comp_cast_type AS cct2,
char_name AS chn,
cast_info AS ci,
company_name AS cn,
info_type AS it,
info_type AS it3,
keyword AS k,
movie_companies AS mc,
movie_info AS mi,
movie_keyword AS mk,
name AS n,
person_info AS pi,
role_type AS rt,
title AS t
WHERE cct1.kind ='cast'
AND cct2.kind ='complete+verified'
AND ci.note IN ('(voice)',
'(voice: Japanese version)',
'(voice) (uncredited)',
'(voice: English version)')
AND cn.country_code ='[us]'
AND it.info = 'release dates'
AND it3.info = 'trivia'
AND k.keyword = 'computer-animation'
AND mi.info IS NOT NULL
AND (mi.info LIKE 'Japan:%200%'
OR mi.info LIKE 'USA:%200%')
AND n.gender ='f'
AND cct2.id = cc.status_id;d_id000 AND 2010


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Aggregate (actual time=115.024..115.035 rows=1 loops=1)
NodeSign: 12118314225425016789
-> Nested Loop (actual time=13.024..107.882 rows=16308 loops=1)
NodeSign: 16222556067297222035
Join Filter: (it3.id = pi.info_type_id)
Rows Removed by Join Filter: 51519
-> Seq Scan on info_type it3 (actual time=0.017..0.031 rows=1 loops=1)
NodeSign: 9388138327776621521
Filter: ((info)::text = 'trivia'::text)
Rows Removed by Filter: 112
-> Nested Loop (actual time=12.951..99.561 rows=67827 loops=1)
NodeSign: 8132073538093871623
Join Filter: (n.id = pi.person_id)
-> Nested Loop (actual time=12.935..57.652 rows=189 loops=1)
NodeSign: 12680341814512330301
Join Filter: (ci.role_id = rt.id)
-> Nested Loop (actual time=12.929..57.246 rows=189 loops=1)
NodeSign: 9818716129878051414
-> Nested Loop (actual time=12.891..52.373 rows=858 loops=1)
NodeSign: 14179132961348800920
Join Filter: (mc.movie_id = t.id)
-> Nested Loop (actual time=12.878..51.508 rows=33 loops=1)
NodeSign: 13250385789945565089
Join Filter: (an.person_id = n.id)
-> Nested Loop (actual time=12.865..51.403 rows=8 loops=1)
NodeSign: 10465605790635078881
Join Filter: (it.id = mi.info_type_id)
-> Nested Loop (actual time=12.855..51.337 rows=8 loops=1)
NodeSign: 17191249967633966537
-> Nested Loop (actual time=6.399..51.255 rows=11 loops=1)
:


File Edit View Search Terminal Help
-> Seq Scan on info_type it (actual time=0.006..0.006 rows=1 loops=8)
NodeSign: 7287576821695634503
Filter: ((info)::text = 'release dates'::text)
Rows Removed by Filter: 15
-> Index Only Scan using person_id_aka_name on aka_name an (actual time=0.008..0.010 rows=4 loops=8)
NodeSign: 2867577293557378872
Index Cond: (person_id = ci.person_id)
Heap Fetches: 0
-> Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.007..0.017 rows=26 loops=33)
NodeSign: 9088741564608473149
Index Cond: (movie_id = ci.movie_id)
-> Index Scan using company_name_pkey on company_name cn (actual time=0.005..0.005 rows=0 loops=858)
NodeSign: 18322911600766040628
Index Cond: (id = mc.company_id)
Filter: ((country_code)::text = '[us]'::text)
Rows Removed by Filter: 1
-> Seq Scan on role_type rt (actual time=0.001..0.001 rows=1 loops=189)
NodeSign: 12736067679374244103
Filter: ((role)::text = 'actress'::text)
Rows Removed by Filter: 1
-> Index Scan using person_id_person_info on person_info pi (actual time=0.012..0.135 rows=359 loops=189)
NodeSign: 9569043262522494575
Index Cond: (person_id = ci.person_id)
Planning Time: 281.065 ms
Execution Time: 115.255 ms
Replan Active: true
Table Entries: 17
Controlled Statements: 1
Replanning Attempts: 2
Total Execution Time: 1041.193 ms
(125 rows)
(END)

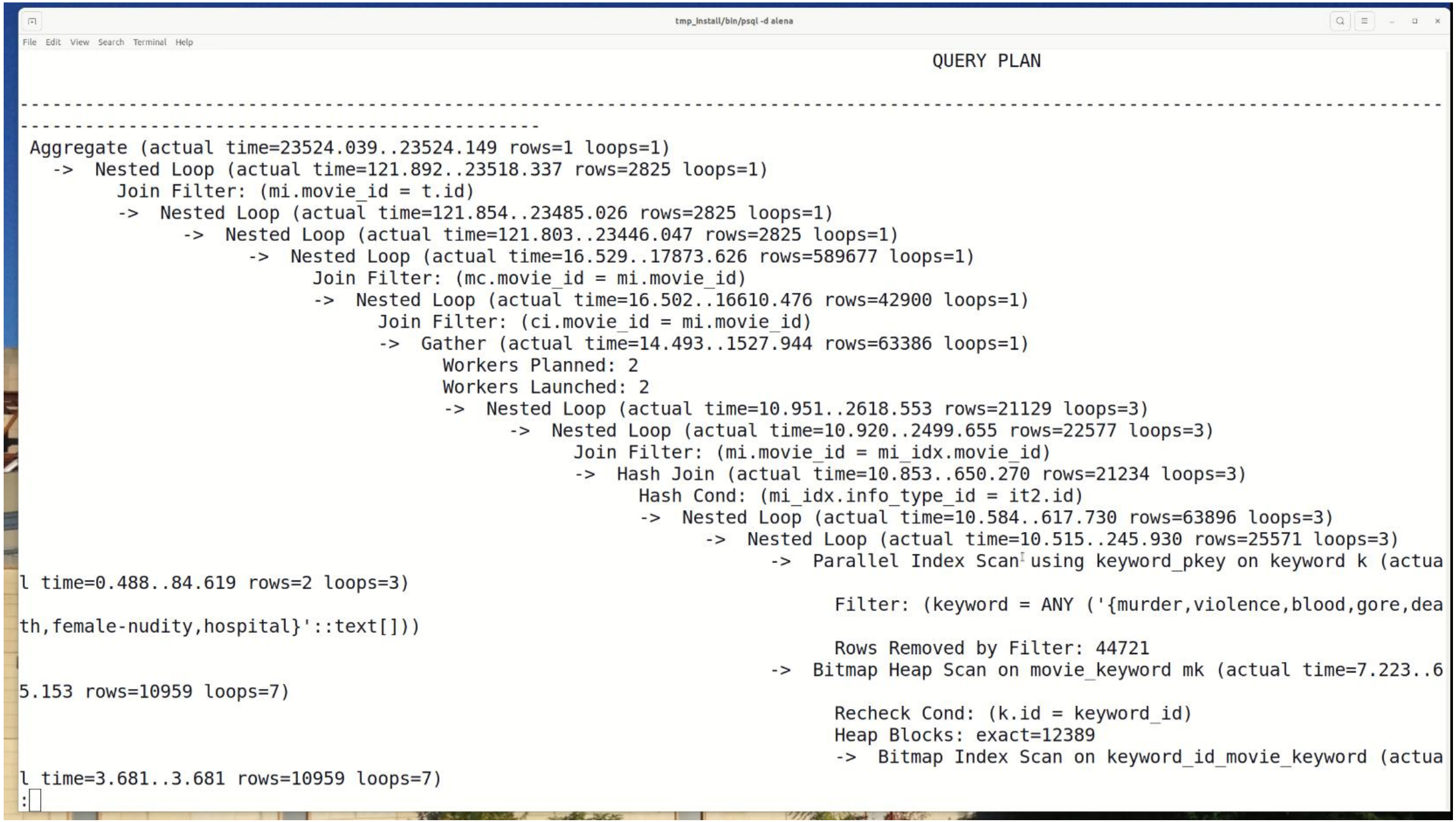

Query execution time: 29c
seconds
4
3.5
3
2.5
2
1.5
1
0.5
0
3.65
1.04
PostgreSQL Execution Time
Replan Total Execution Time
Attempts: 2
Timeout: 0.4 sec


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
FROM company_name AS cn,
company_type AS ct,
keyword AS k,
link_type AS lt,
movie_companies AS mc,
movie_keyword AS mk,
movie_link AS ml,
title AS t
WHERE cn.country_code !='[pl]'
AND (cn.name LIKE '20th Century Fox%'
OR cn.name LIKE 'Twentieth Century Fox%')
AND ct.kind != 'production companies'
AND ct.kind IS NOT NULL
AND k.keyword IN ('sequel',
'revenge',
'based-on-novel')
AND mc.note IS NOT NULL
AND t.production_year > 1950
AND lt.id = ml.link_type_id
AND ml.movie_id = t.id
AND t.id = mk.movie_id
AND mk.keyword_id = k.id
AND t.id = mc.movie_id
AND mc.company_type_id = ct.id
AND mc.company_id = cn.id
AND ml.movie_id = mk.movie_id
AND ml.movie_id = mc.movie_id
AND mk.movie_id = mc.movie_id;
alena=# SET show_node_sign = 'off';
SET query_inadequate_execution_time = -1;
SET replan_regression_mode = 'off';
SET
SET
SET
alena=#

tmp_install/bin/psql -d alena

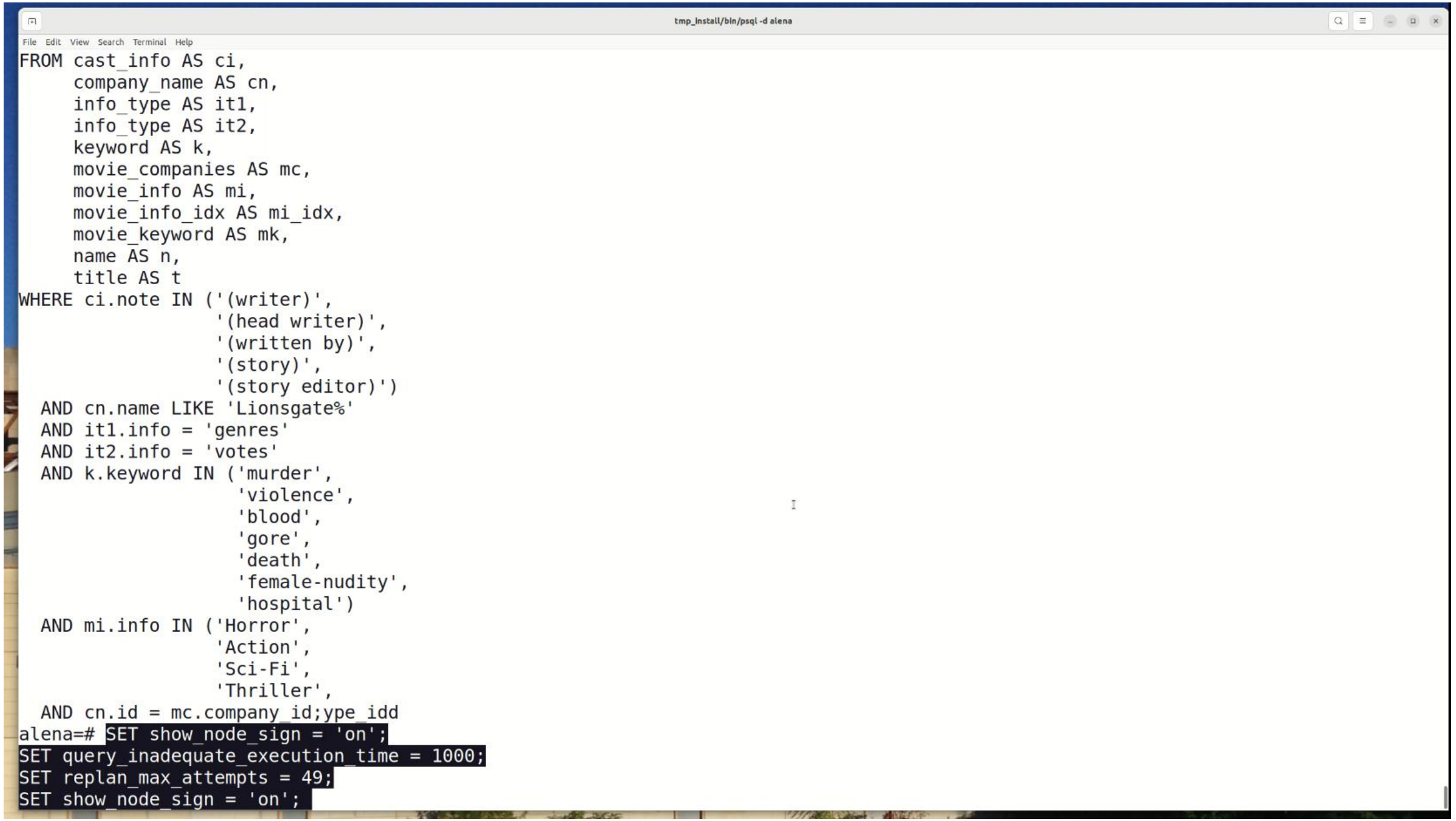
File Edit View Search Terminal Help

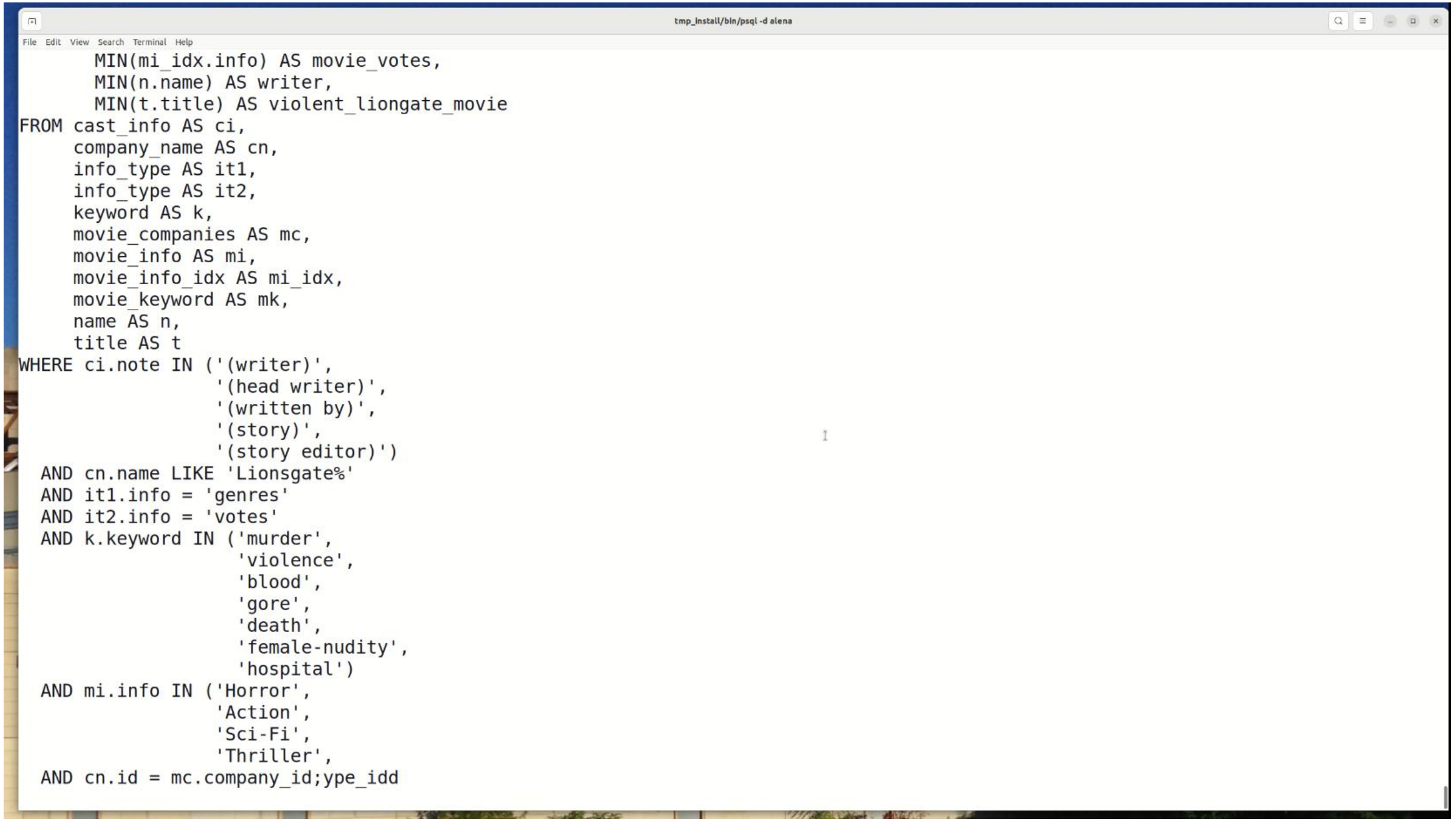
```
       MIN(mi_idx.info) AS movie_votes,
       MIN(n.name) AS writer,
       MIN(t.title) AS violent_liongate_movie
FROM cast_info AS ci,
     company_name AS cn,
     info_type AS it1,
     info_type AS it2,
     keyword AS k,
     movie_companies AS mc,
     movie_info AS mi,
     movie_info_idx AS mi_idx,
     movie_keyword AS mk,
     name AS n,
     title AS t
WHERE ci.note IN ('(writer)',
                  '(head writer)',
                  '(written by)',
                  '(story)',
                  '(story editor)')
  AND cn.name LIKE 'Lionsgate%'
  AND it1.info = 'genres'
  AND it2.info = 'votes'
  AND k.keyword IN ('murder',
                    'violence',
                    'blood',
                    'gore',
                    'death',
                    'female-nudity',
                    'hospital')
  AND mi.info IN ('Horror',
                  'Action',
                  'Sci-Fi',
                  'Thriller',
  AND cn.id = mc.company_id;ype_idd
```

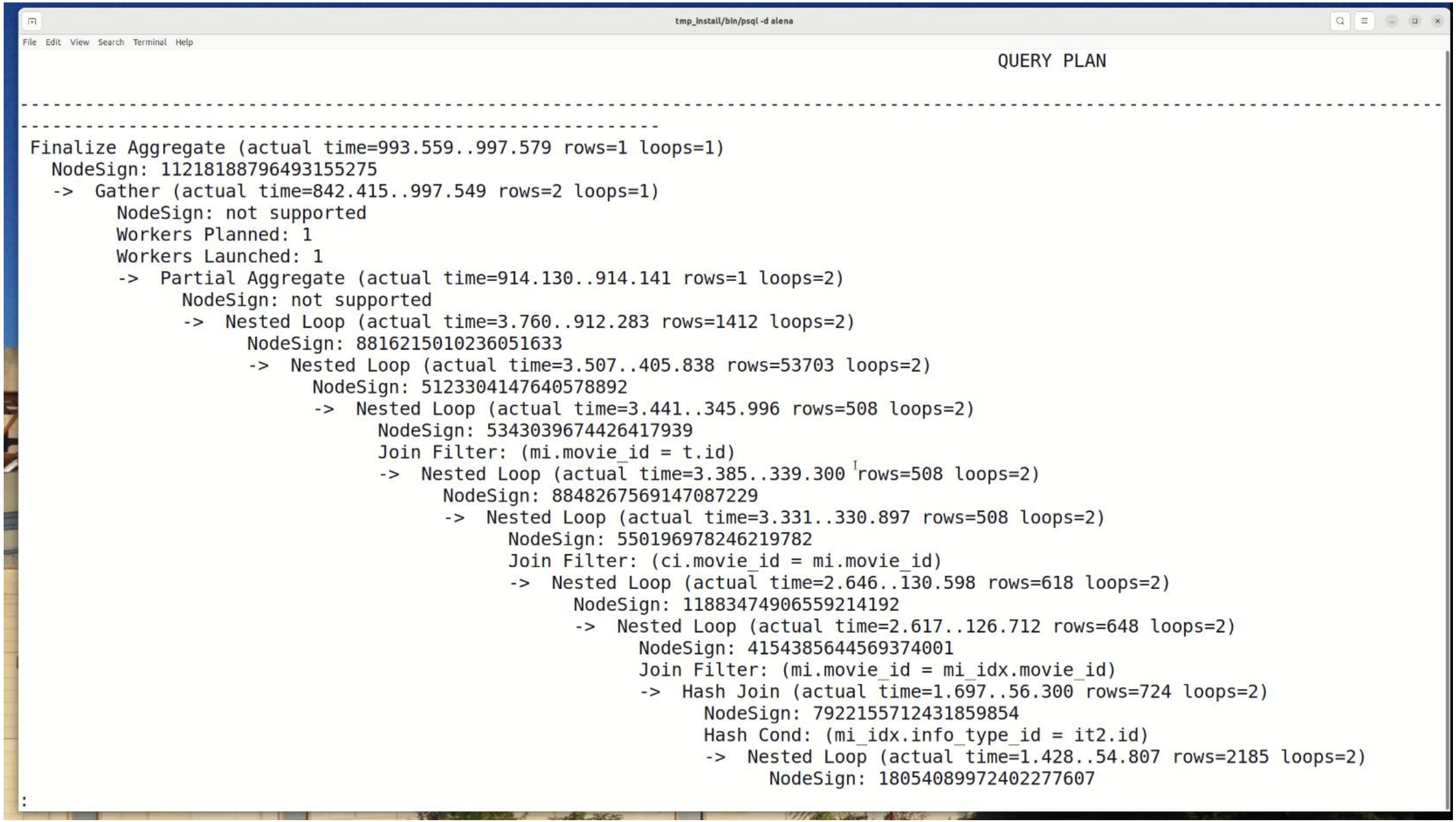

tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Aggregate (actual time=23524.039..23524.149 rows=1 loops=1)
-> Nested Loop (actual time=121.892..23518.337 rows=2825 loops=1)
Join Filter: (mi.movie_id = t.id)
-> Nested Loop (actual time=121.854..23485.026 rows=2825 loops=1)
-> Nested Loop (actual time=121.803..23446.047 rows=2825 loops=1)
-> Nested Loop (actual time=16.529..17873.626 rows=589677 loops=1)
Join Filter: (mc.movie_id = mi.movie_id)
-> Nested Loop (actual time=16.502..16610.476 rows=42900 loops=1)
Join Filter: (ci.movie_id = mi.movie_id)
-> Gather (actual time=14.493..1527.944 rows=63386 loops=1)
Workers Planned: 2
Workers Launched: 2
-> Nested Loop (actual time=10.951..2618.553 rows=21129 loops=3)
-> Nested Loop (actual time=10.920..2499.655 rows=22577 loops=3)
Join Filter: (mi.movie_id = mi_idx.movie_id)
-> Hash Join (actual time=10.853..650.270 rows=21234 loops=3)
Hash Cond: (mi_idx.info_type_id = it2.id)
-> Nested Loop (actual time=10.584..617.730 rows=63896 loops=3)
-> Nested Loop (actual time=10.515..245.930 rows=25571 loops=3)
-> Parallel Index Scan using keyword_pkey on keyword k (actua
l time=0.488..84.619 rows=2 loops=3)
Filter: (keyword = ANY ('{murder,violence,blood,gore,dea
th,female-nudity,hospital}'::text[]))
Rows Removed by Filter: 44721
-> Bitmap Heap Scan on movie_keyword mk (actual time=7.223..6
5.153 rows=10959 loops=7)
Recheck Cond: (k.id = keyword_id)
Heap Blocks: exact=12389
-> Bitmap Index Scan on keyword_id_movie_keyword (actua
l time=3.681..3.681 rows=10959 loops=7)
:

File Edit View Search Terminal Help

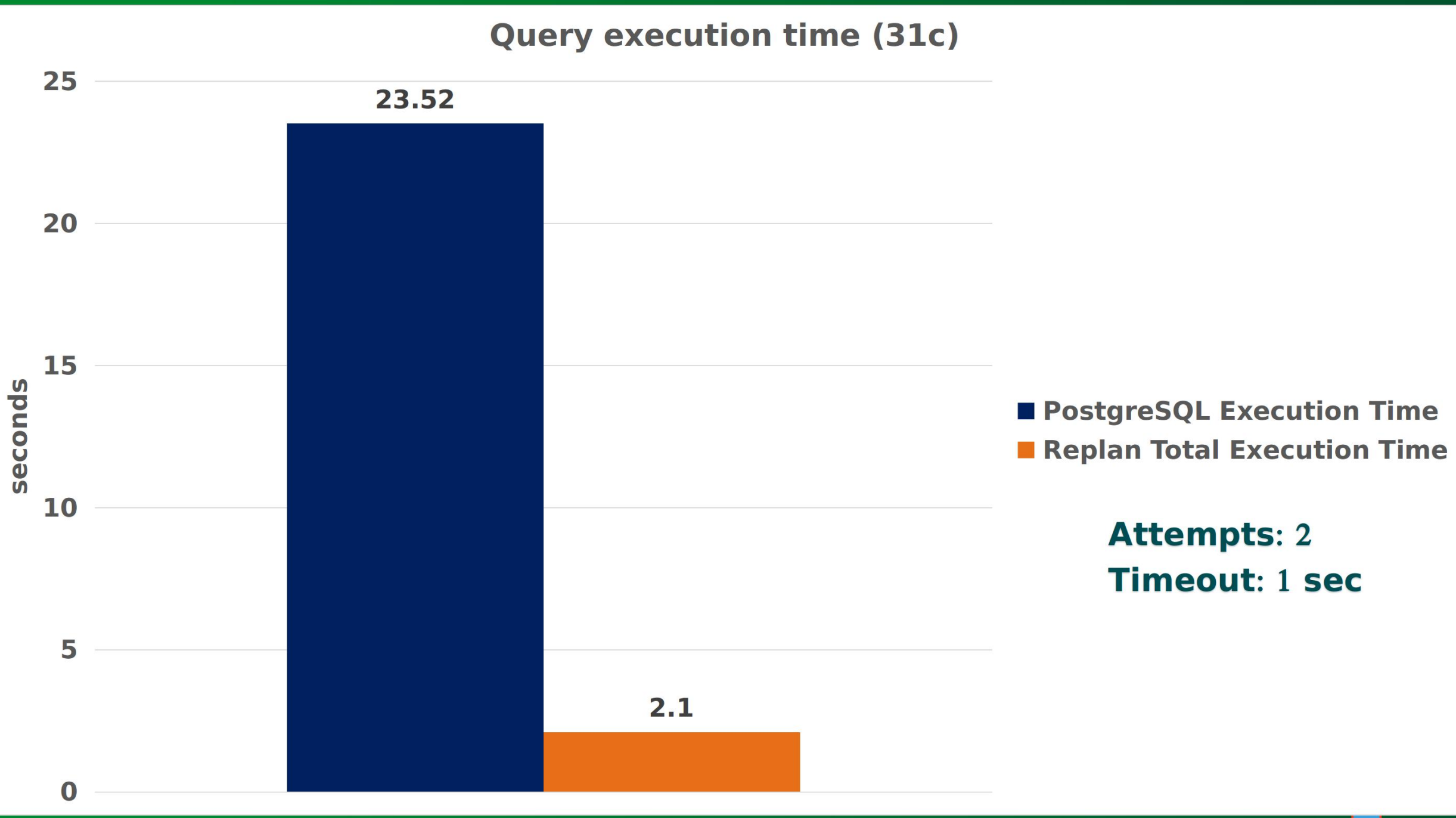
```
=3)
                                                        Filter: ((info)::text = 'votes'::text)
                                                        Rows Removed by Filter: 112
                                                ->  Index Scan using movie_id_movie_info on movie_info mi (actual time=0.055..0.
086 rows=1 loops=63701)
                                                      Index Cond: (movie_id = mk.movie_id)
                                                      Filter: (info = ANY ('{Horror,Action,Sci-Fi,Thriller,Crime,War}'::text[]))
                                                      Rows Removed by Filter: 58
                                              ->  Index Scan using info_type_pkey on info_type it1 (actual time=0.004..0.004 rows=1
loops=67732)
                                                    Index Cond: (id = mi.info_type_id)
                                                    Filter: ((info)::text = 'genres'::text)
                                                    Rows Removed by Filter: 0
                                          ->  Index Scan using movie_id_cast_info on cast_info ci (actual time=0.187..0.237 rows=1 loops=633
86)
                                                Index Cond: (movie_id = mk.movie_id)
                                                Filter: (note = ANY ('{(writer),"(head writer)","(written by)",(story),"(story editor)"}'::t
ext[]))
                                                Rows Removed by Filter: 63
                                        ->  Index Scan using movie_id_movie_companies on movie_companies mc (actual time=0.012..0.022 rows=14 lo
ops=42900)
                                              Index Cond: (movie_id = mk.movie_id)
                                    ->  Index Scan using company_name_pkey on company_name cn (actual time=0.009..0.009 rows=0 loops=589677)
                                          Index Cond: (id = mc.company_id)
                                          Filter: (name ~~ 'Lionsgate%'::text)
                                          Rows Removed by Filter: 1
                                ->  Index Scan using name_pkey on name n (actual time=0.012..0.012 rows=1 loops=2825)
                                      Index Cond: (id = ci.person_id)
                          ->  Index Scan using title_pkey on title t (actual time=0.010..0.010 rows=1 loops=2825)
                                Index Cond: (id = mk.movie_id)
 Planning Time: 111.464 ms
 Execution Time: 23524.423 ms
(58 rows)

(END)
```


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
FROM cast_info AS ci,
company_name AS cn,
info_type AS it1,
info_type AS it2,
keyword AS k,
movie_companies AS mc,
movie_info AS mi,
movie_info_idx AS mi_idx,
movie_keyword AS mk,
name AS n,
title AS t
WHERE ci.note IN ('(writer)',
'(head writer)',
'(written by)',
'(story)',
'(story editor)')
AND cn.name LIKE 'Lionsgate%'
AND it1.info = 'genres'
AND it2.info = 'votes'
AND k.keyword IN ('murder',
'violence',
'blood',
'gore',
'death',
'female-nudity',
'hospital')
AND mi.info IN ('Horror',
'Action',
'Sci-Fi',
'Thriller',
AND cn.id = mc.company_id;ype_idd
alena=# SET show_node_sign = 'on';
SET query_inadequate_execution_time = 1000;
SET replan_max_attempts = 49;
SET show_node_sign = 'on';


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
MIN(mi_idx.info) AS movie_votes,
MIN(n.name) AS writer,
MIN(t.title) AS violent_liongate_movie
FROM cast_info AS ci,
company_name AS cn,
info_type AS it1,
info_type AS it2,
keyword AS k,
movie_companies AS mc,
movie_info AS mi,
movie_info_idx AS mi_idx,
movie_keyword AS mk,
name AS n,
title AS t
WHERE ci.note IN ('(writer)',
'(head writer)',
'(written by)',
'(story)',
'(story editor)')
AND cn.name LIKE 'Lionsgate%'
AND it1.info = 'genres'
AND it2.info = 'votes'
AND k.keyword IN ('murder',
'violence',
'blood',
'gore',
'death',
'female-nudity',
'hospital')
AND mi.info IN ('Horror',
'Action',
'Sci-Fi',
'Thriller',
AND cn.id = mc.company_id;ype_idd


tmp_install/bin/psql -d alena
File Edit View Search Terminal Help
QUERY PLAN
Finalize Aggregate (actual time=993.559..997.579 rows=1 loops=1)
NodeSign: 11218188796493155275
-> Gather (actual time=842.415..997.549 rows=2 loops=1)
NodeSign: not supported
Workers Planned: 1
Workers Launched: 1
-> Partial Aggregate (actual time=914.130..914.141 rows=1 loops=2)
NodeSign: not supported
-> Nested Loop (actual time=3.760..912.283 rows=1412 loops=2)
NodeSign: 8816215010236051633
-> Nested Loop (actual time=3.507..405.838 rows=53703 loops=2)
NodeSign: 5123304147640578892
-> Nested Loop (actual time=3.441..345.996 rows=508 loops=2)
NodeSign: 5343039674426417939
Join Filter: (mi.movie_id = t.id)
-> Nested Loop (actual time=3.385..339.300 rows=508 loops=2)
NodeSign: 8848267569147087229
-> Nested Loop (actual time=3.331..330.897 rows=508 loops=2)
NodeSign: 550196978246219782
Join Filter: (ci.movie_id = mi.movie_id)
-> Nested Loop (actual time=2.646..130.598 rows=618 loops=2)
NodeSign: 11883474906559214192
-> Nested Loop (actual time=2.617..126.712 rows=648 loops=2)
NodeSign: 4154385644569374001
Join Filter: (mi.movie_id = mi_idx.movie_id)
-> Hash Join (actual time=1.697..56.300 rows=724 loops=2)
NodeSign: 7922155712431859854
Hash Cond: (mi_idx.info_type_id = it2.id)
-> Nested Loop (actual time=1.428..54.807 rows=2185 loops=2)
NodeSign: 18054089972402277607
:

```
File  Edit  View  Search  Terminal  Help
                                                  Index Cond: (id = mi.info_type_id)
                                                  Filter: ((info)::text = 'genres'::text)
                                                  Rows Removed by Filter: 0
                                           ->  Index Scan using movie_id_cast_info on cast_info ci (actual time=0.239..0.323 rows
=1 loops=1235)
                                                 NodeSign: 14131283812421365639
                                                 Index Cond: (movie_id = mc.movie_id)
                                                 Filter: (note = ANY ('{(writer),"(head writer)","(written by)",(story),"(story e
ditor)"}'::text[]))
                                                 Rows Removed by Filter: 102
                                        ->  Index Scan using name_pkey on name n (actual time=0.015..0.015 rows=1 loops=1017)
                                              NodeSign: 2703763068334705397
                                              Index Cond: (id = ci.person_id)
                                     ->  Index Scan using title_pkey on title t (actual time=0.011..0.011 rows=1 loops=1017)
                                           NodeSign: 678843994618044636
                                           Index Cond: (id = mc.movie_id)
                                ->  Index Scan using movie_id_movie_keyword on movie_keyword mk (actual time=0.015..0.080 rows=106 loops
=1017)
                                      NodeSign: 10752057836713899998
                                      Index Cond: (movie_id = t.id)
                           ->  Index Scan using keyword_pkey on keyword k (actual time=0.009..0.009 rows=0 loops=107406)
                                 NodeSign: 13217407192521347227
                                 Index Cond: (id = mk.keyword_id)
                                 Filter: (keyword = ANY ('{murder,violence,blood,gore,death,female-nudity,hospital}'::text[]))
                                 Rows Removed by Filter: 1
 Planning Time: 146.741 ms
 Execution Time: 997.913 ms
 Replan Active: true
 Table Entries: 11
 Controlled Statements: 1
 Replanning Attempts: 1
 Total Execution Time: 2010.402 ms
(85 rows)

(END)
```


Query execution time (31c)
25
20
15
10
5
0
seconds
23.52
2.1
PostgreSQL Execution Time
Replan Total Execution Time
Attempts: 2
Timeout: 1 sec