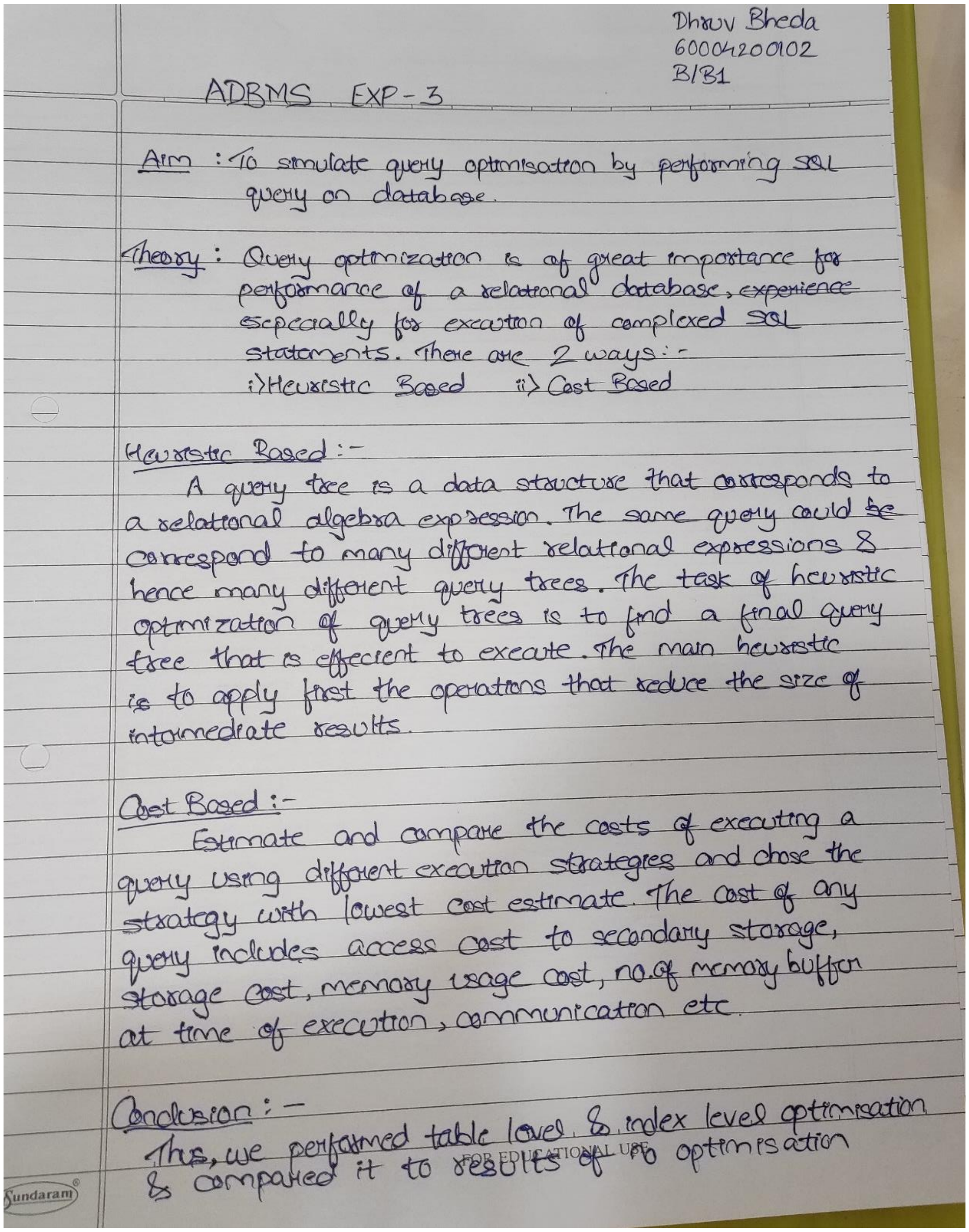
Name: Dhruv Bheda **SapID:** 60004200102
Batch: B1

ADBMS
Experiment-3



Dhruv Bheda
60004200102
B/B1

ADBMS EXP-3

Aim : To simulate query optimisation by performing SQL query on database.

Theory : Query optimization is of great importance for performance of a relational database, experience especially for execution of complexed SQL statements. There are 2 ways:-
i) Heuristic Based ii) Cost Based

Heuristic Based :-
A query tree is a data structure that corresponds to a relational algebra expression. The same query could be correspond to many different relational expressions & hence many different query trees. The task of heuristic optimization of query trees is to find a final query tree that is effecient to execute. The main heuristic is to apply first the operations that reduce the size of intermediate results.

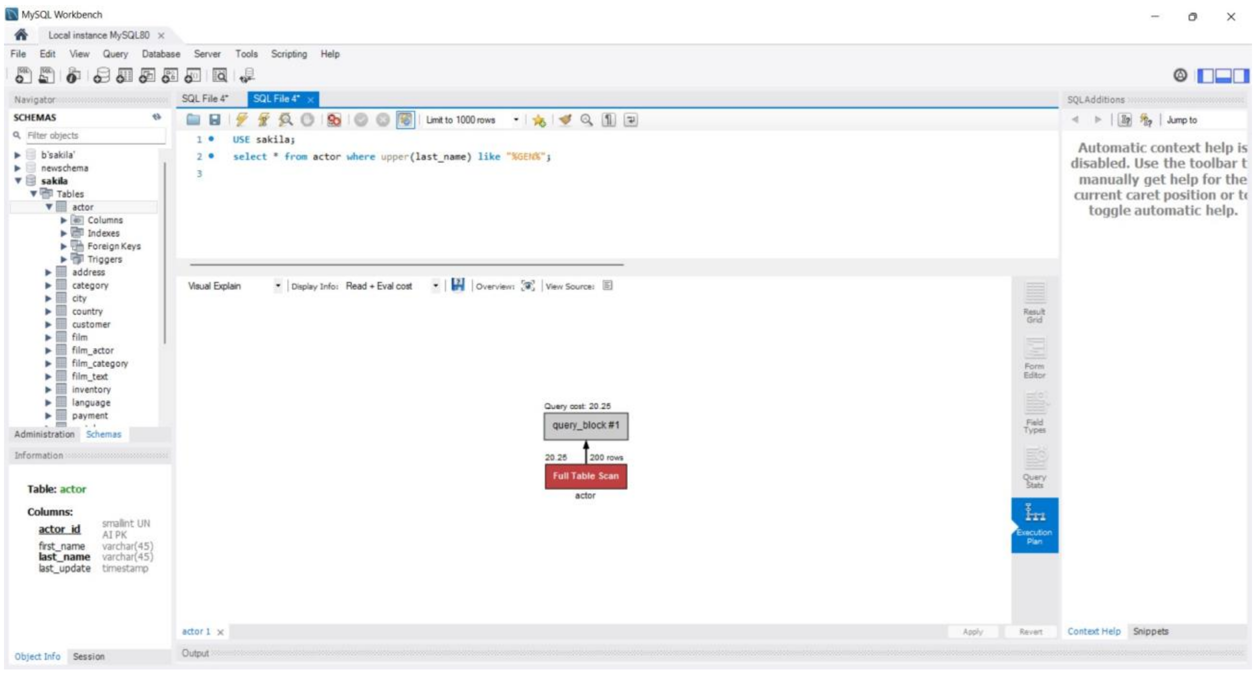
Cost Based :-
Estimate and compare the costs of executing a query using different execution strategies and chose the strategy with lowest cost estimate. The cost of any query includes access cost to secondary storage, storage cost, memory usage cost, no. of memory buffer at time of execution, communication etc.

Conclusion :-
Thus, we performed table level & index level optimisation & compared it to results of no optimisation

FOR EDUCATIONAL USE

Sundaram

1) SELECT QUERY



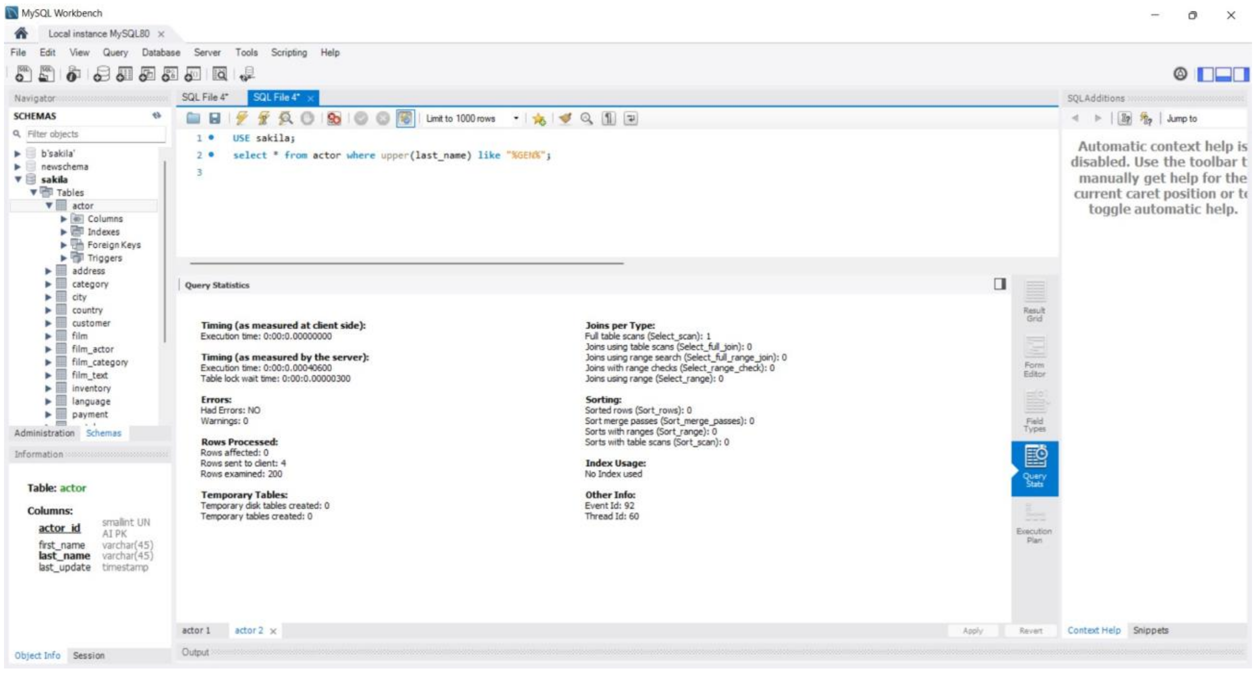
```sql
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
```

Table: actor

Columns:

actor_id	smallint UN AI PK
first_name	varchar(45)
last_name	varchar(45)
last_update	timestamp

BEFORE OPTIMIZING

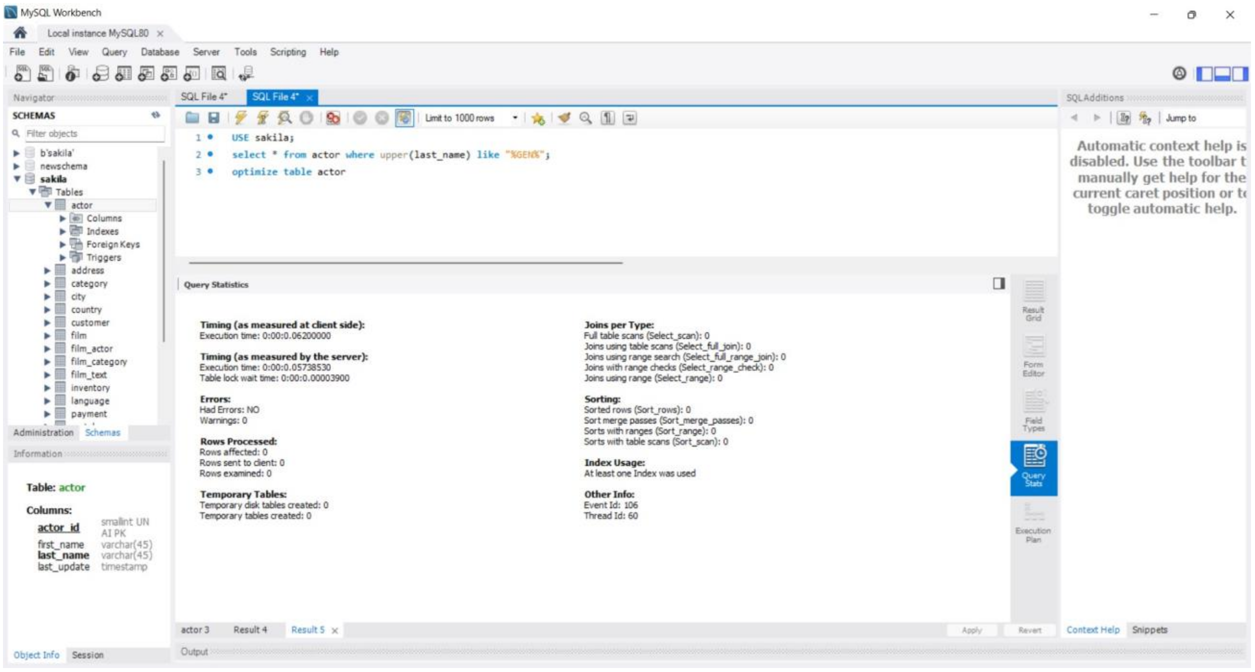


```sql
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
```

Query Statistics

```
Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00040600
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 4
Rows examined: 200

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
No Index used

Other Info:
Event Id: 92
Thread Id: 60
```

AFTER OPTIMIZING

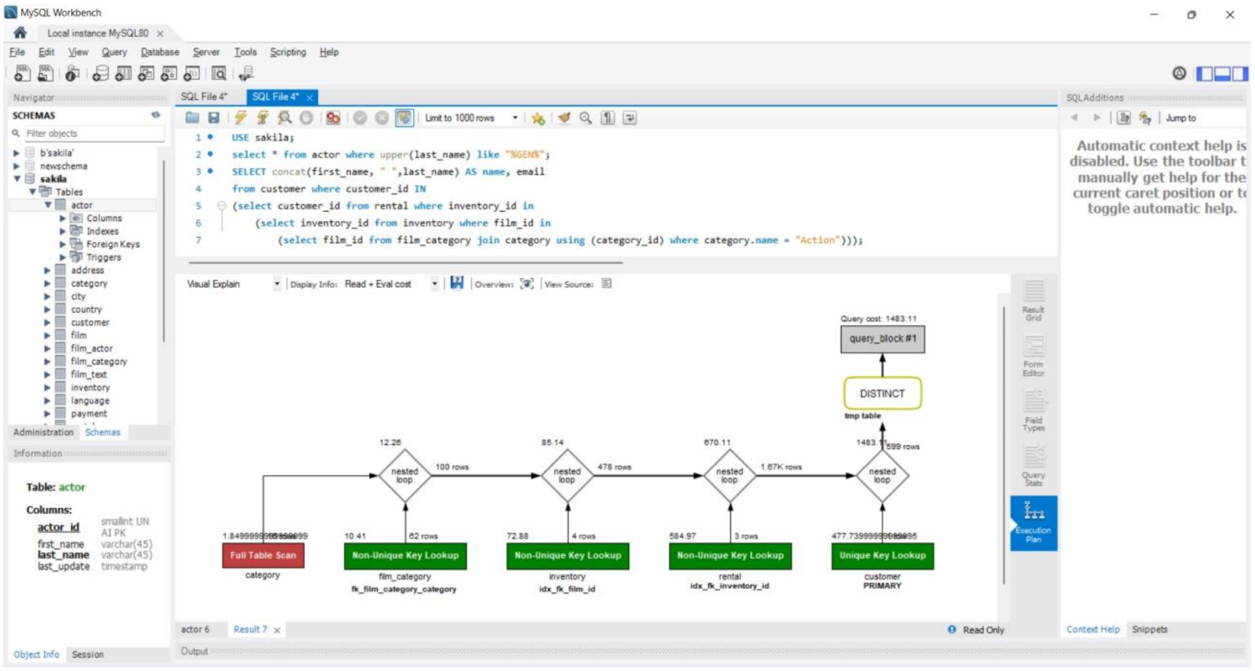


```sql
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
optimize table actor
```

Query Statistics

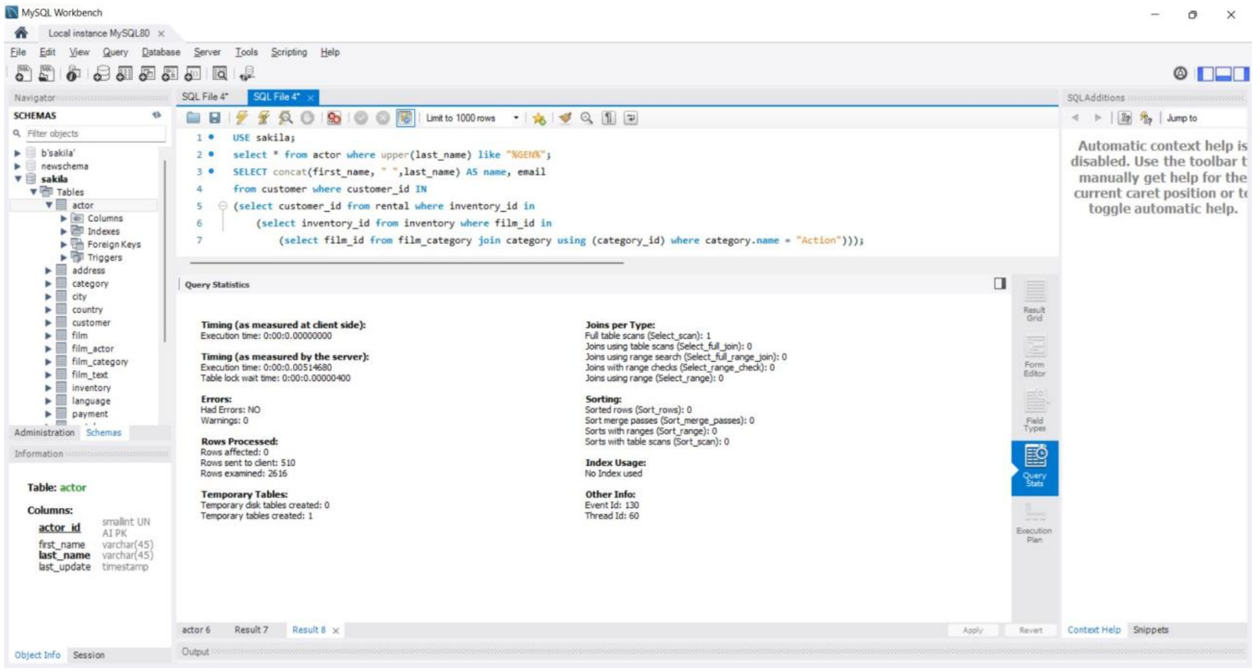
```
Timing (as measured at client side):
Execution time: 0:00:0.06200000

Timing (as measured by the server):
Execution time: 0:00:0.05738530
Table lock wait time: 0:00:0.00003900

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 0
Rows examined: 0

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 106
Thread Id: 60
```

2) NESTED



```sql
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
SELECT concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));
```

BEFORE OPTIMIZING



```sql
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
SELECT concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));
```

```
Query Statistics

Timing (as measured at client side):          Joins per Type:
Execution time: 0:00:0.00000000               Full table scans (Select_scan): 1
                                              Joins using table scans (Select_full_join): 0
Timing (as measured by the server):           Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.00514680               Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00000400         Joins using range (Select_range): 0

Errors:                                       Sorting:
Had Errors: NO                                Sorted rows (Sort_rows): 0
Warnings: 0                                   Sort merge passes (Sort_merge_passes): 0
                                              Sorts with ranges (Sort_range): 0
Rows Processed:                               Sorts with table scans (Sort_scan): 0
Rows affected: 0
Rows sent to client: 510                      Index Usage:
Rows examined: 2616                           No Index used

Temporary Tables:                             Other Info:
Temporary disk tables created: 0              Event Id: 130
Temporary tables created: 1                   Thread Id: 60
```

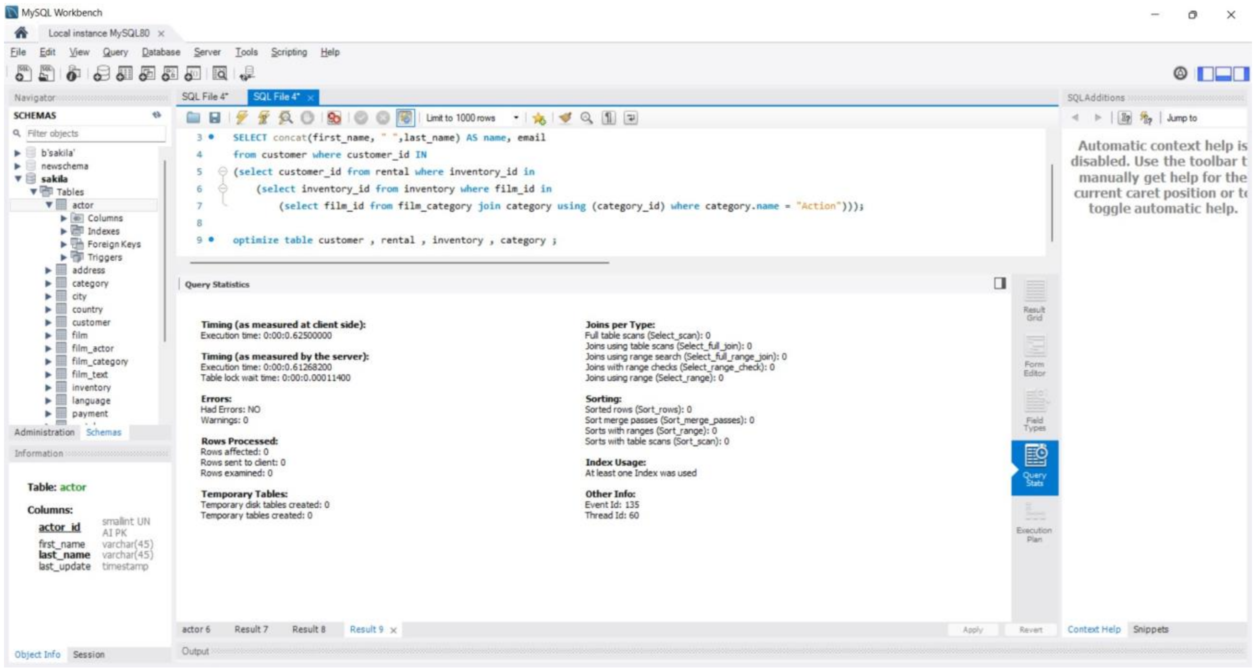
Table: actor

Columns:

actor_id	smallint UN AI PK
first_name	varchar(45)
last_name	varchar(45)
last_update	timestamp

Automatic context help is disabled. Use the toolbar t manually get help for the current caret position or t toggle automatic help.

AFTER OPTIMIZING



```sql
SELECT concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));

optimize table customer , rental , inventory , category ;
```

```
Query Statistics

Timing (as measured at client side):          Joins per Type:
Execution time: 0:00:0.62500000               Full table scans (Select_scan): 0
                                              Joins using table scans (Select_full_join): 0
Timing (as measured by the server):           Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.61268200               Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00011400         Joins using range (Select_range): 0

Errors:                                       Sorting:
Had Errors: NO                                Sorted rows (Sort_rows): 0
Warnings: 0                                   Sort merge passes (Sort_merge_passes): 0
                                              Sorts with ranges (Sort_range): 0
Rows Processed:                               Sorts with table scans (Sort_scan): 0
Rows affected: 0
Rows sent to client: 0                        Index Usage:
Rows examined: 0                              At least one Index was used

Temporary Tables:                             Other Info:
Temporary disk tables created: 0              Event Id: 135
Temporary tables created: 0                   Thread Id: 60
```

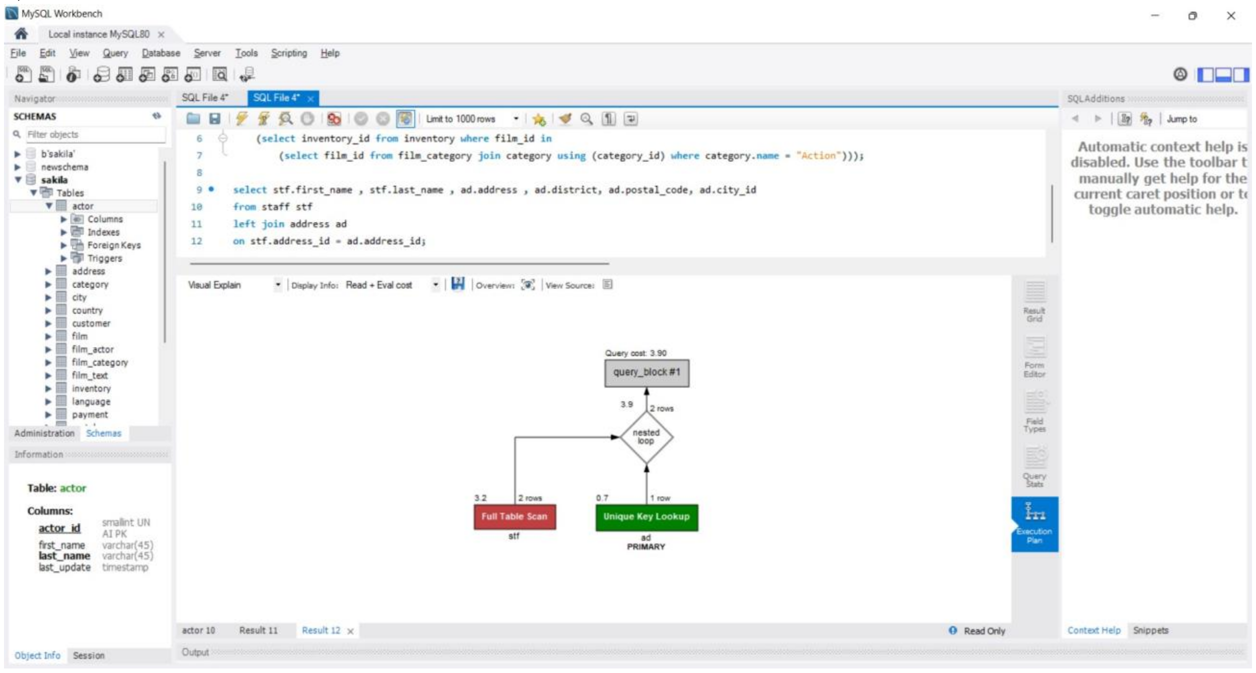
Table: actor

Columns:

actor_id	smallint UN AI PK
first_name	varchar(45)
last_name	varchar(45)
last_update	timestamp

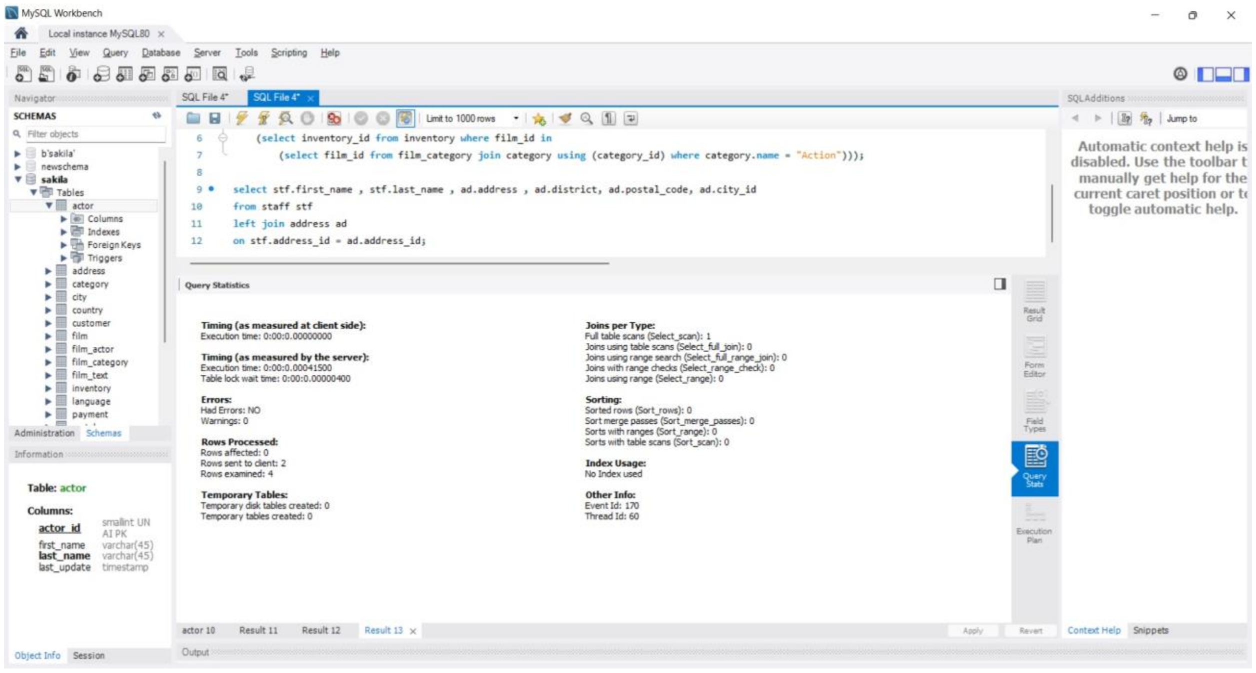
Automatic context help is disabled. Use the toolbar t manually get help for the current caret position or t toggle automatic help.

3) LEFT JOIN



```
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));

select stf.first_name , stf.last_name , ad.address , ad.district, ad.postal_code, ad.city_id
from staff stf
left join address ad
on stf.address_id = ad.address_id;
```

BEFORE OPTIMIZING

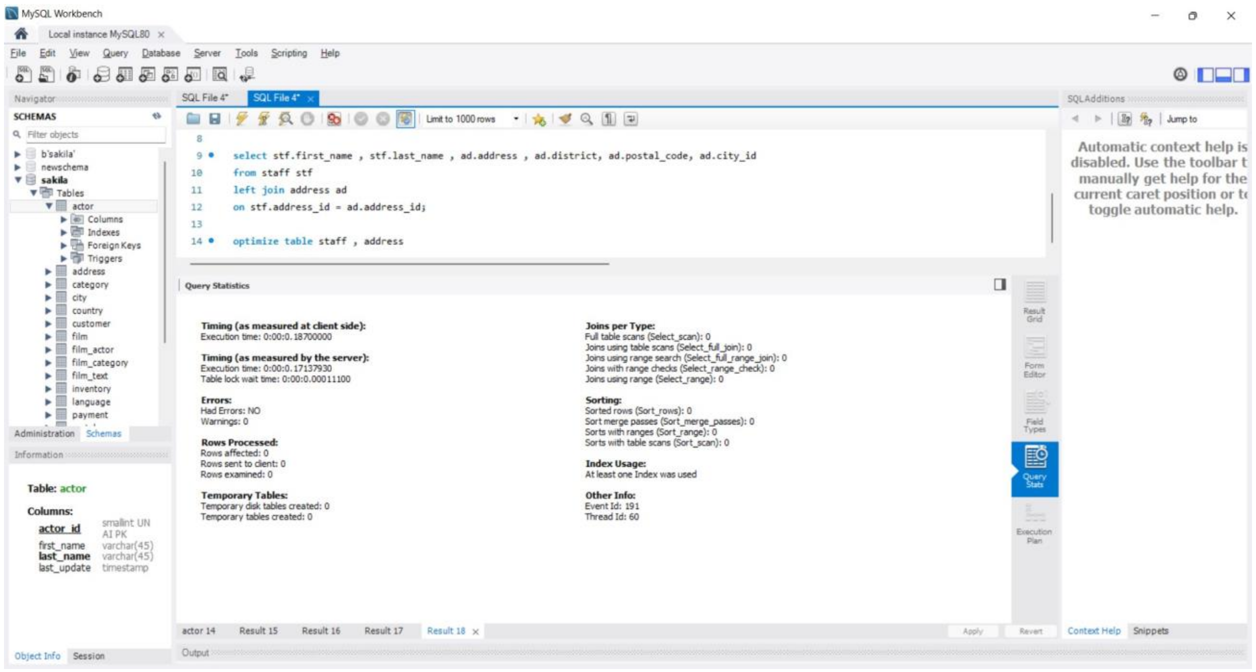


```
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));

select stf.first_name , stf.last_name , ad.address , ad.district, ad.postal_code, ad.city_id
from staff stf
left join address ad
on stf.address_id = ad.address_id;
```

Query Statistics

```
Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00041500
Table lock wait time: 0:00:0.00000400

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 2
Rows examined: 4

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
No Index used

Other Info:
Event Id: 170
Thread Id: 60
```

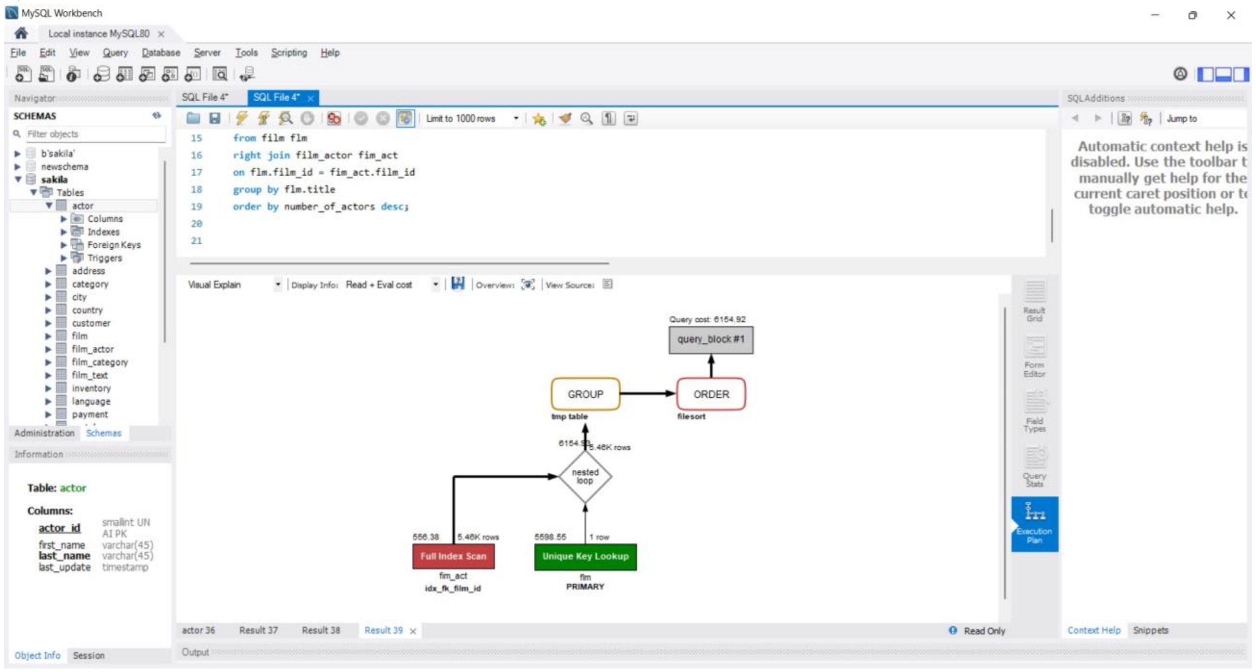
AFTER OPTIMIZING



```sql
select stf.first_name , stf.last_name , ad.address , ad.district, ad.postal_code, ad.city_id
from staff stf
left join address ad
on stf.address_id = ad.address_id;

optimize table staff , address
```

```
Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.18700000

Timing (as measured by the server):
Execution time: 0:00:0.17137930
Table lock wait time: 0:00:0.00011100

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 0
Rows examined: 0

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 191
Thread Id: 60
```

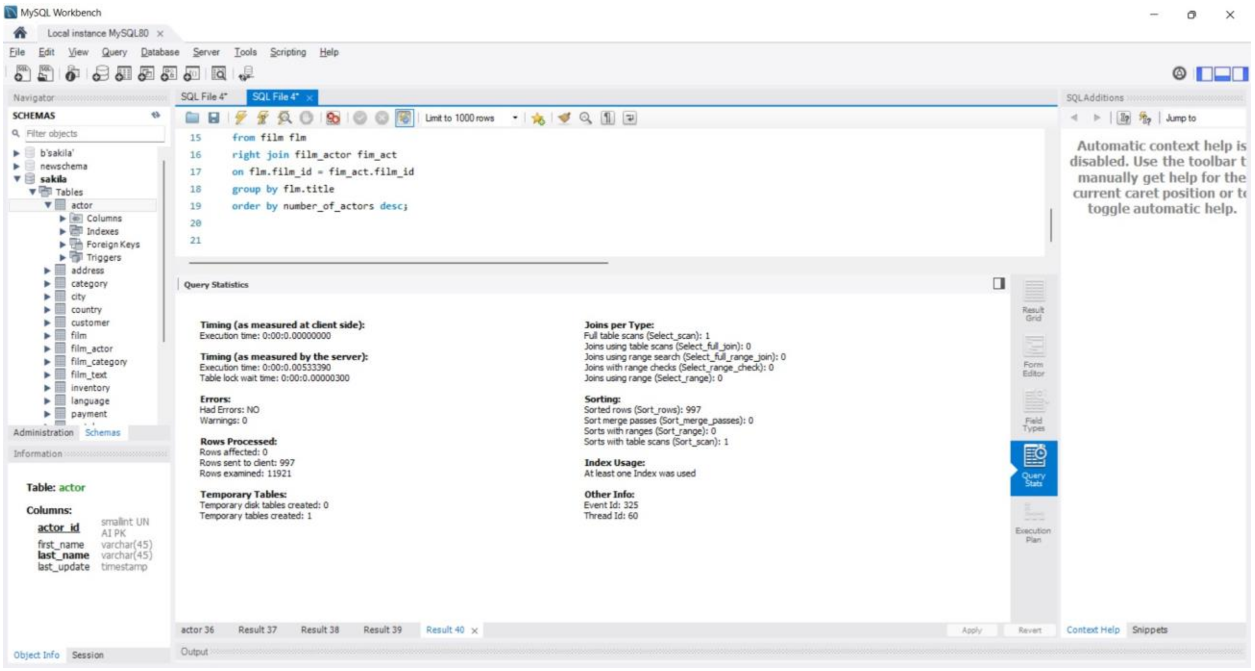
4) RIGHT JOIN



```sql
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

Visual Explain | Display Info: Read + Eval cost

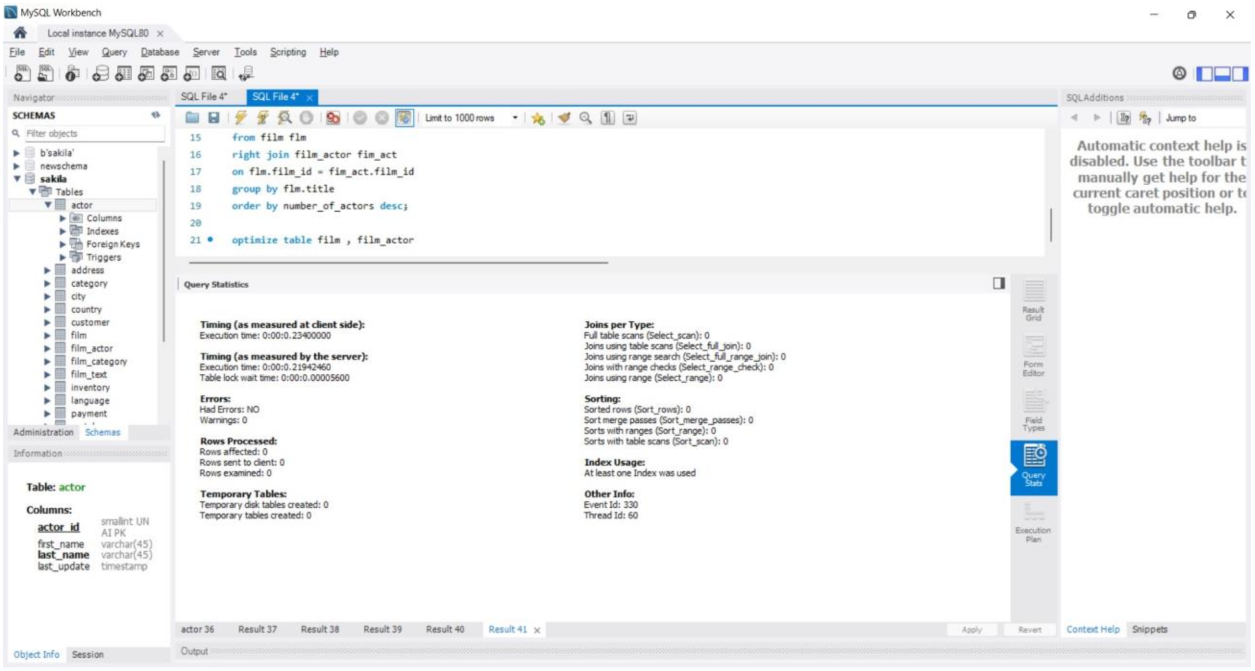
BEFORE OPTIMIZING



```sql
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

```
Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00533390
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 997
Rows examined: 11921

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 1

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 997
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 1

Index Usage:
At least one Index was used

Other Info:
Event Id: 325
Thread Id: 60
```

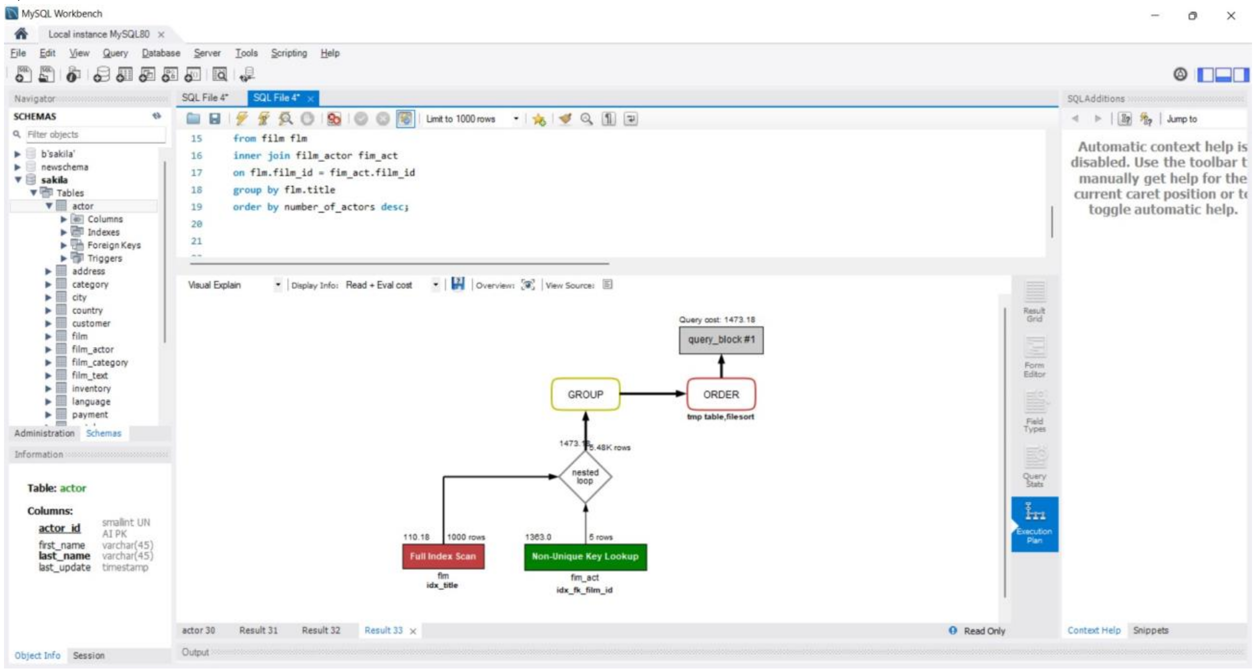
AFTER OPTIMIZING



```sql
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;

optimize table film , film_actor
```

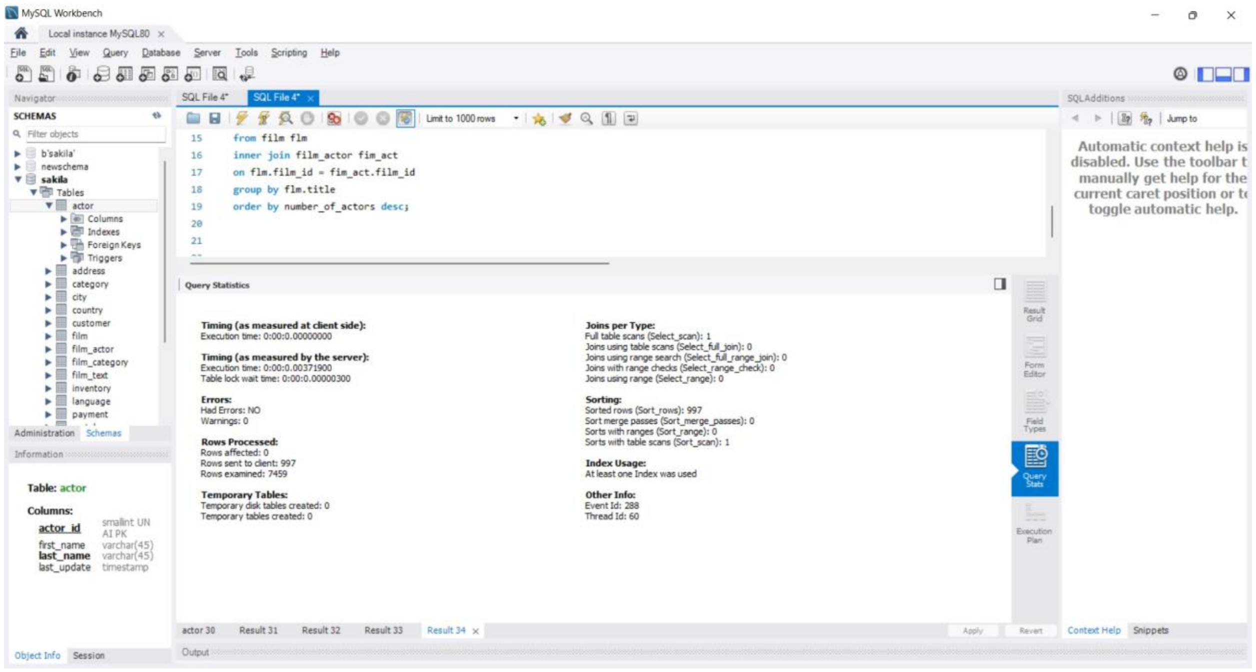
```
Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.23400000

Timing (as measured by the server):
Execution time: 0:00:0.21942460
Table lock wait time: 0:00:0.00005600

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 0
Rows examined: 0

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 330
Thread Id: 60
```

5) INNER JOIN



```
from film flm
inner join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

BEFORE OPTIMIZING



```
from film flm
inner join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00371900
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 997
Rows examined: 7459

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

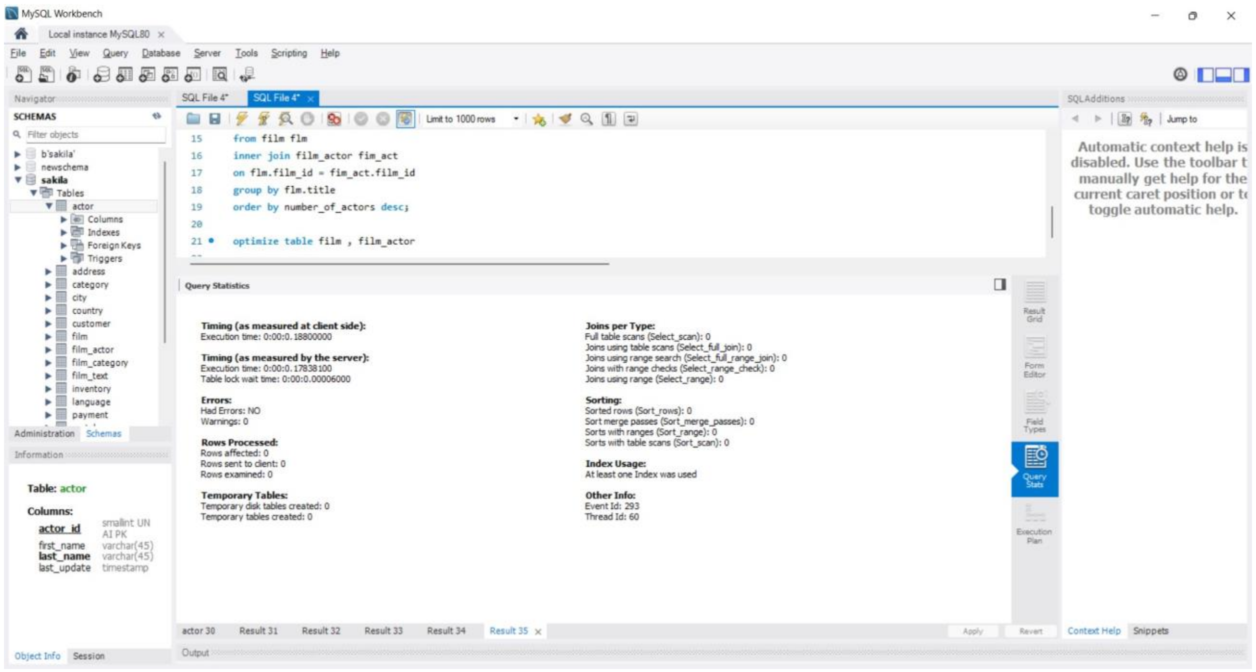
Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 997
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 1

Index Usage:
At least one Index was used

Other Info:
Event Id: 288
Thread Id: 60

AFTER OPTIMIZING

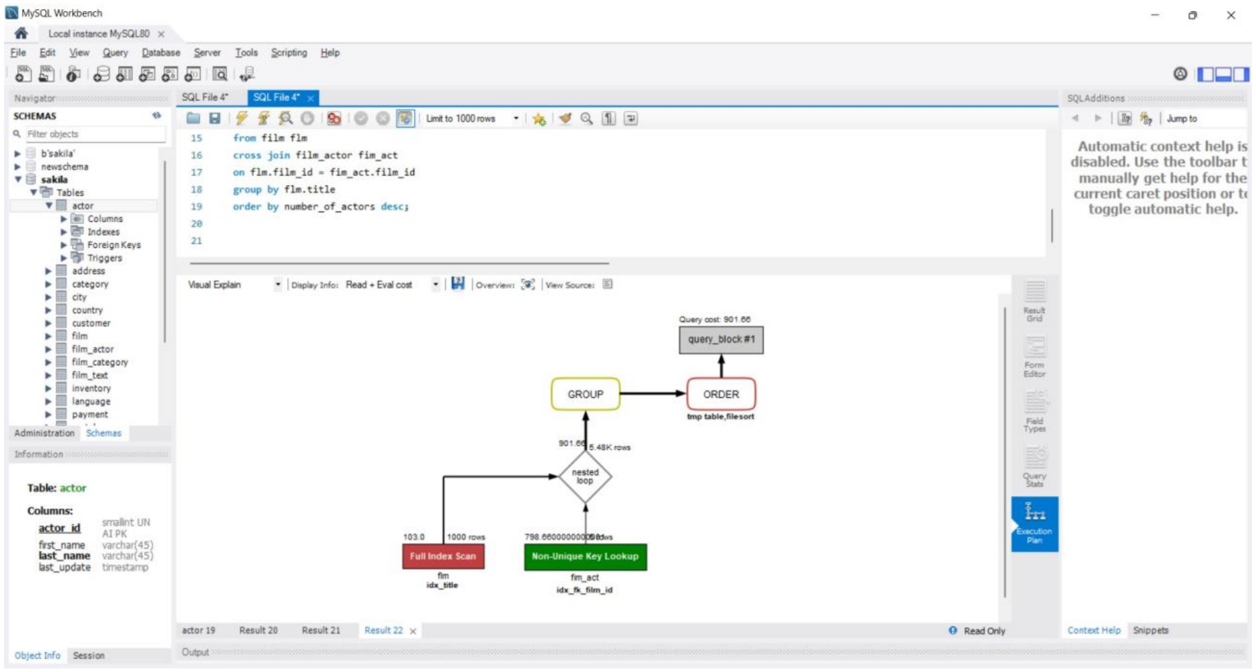


```
from film flm
inner join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;

optimize table film , film_actor
```

Query Statistics

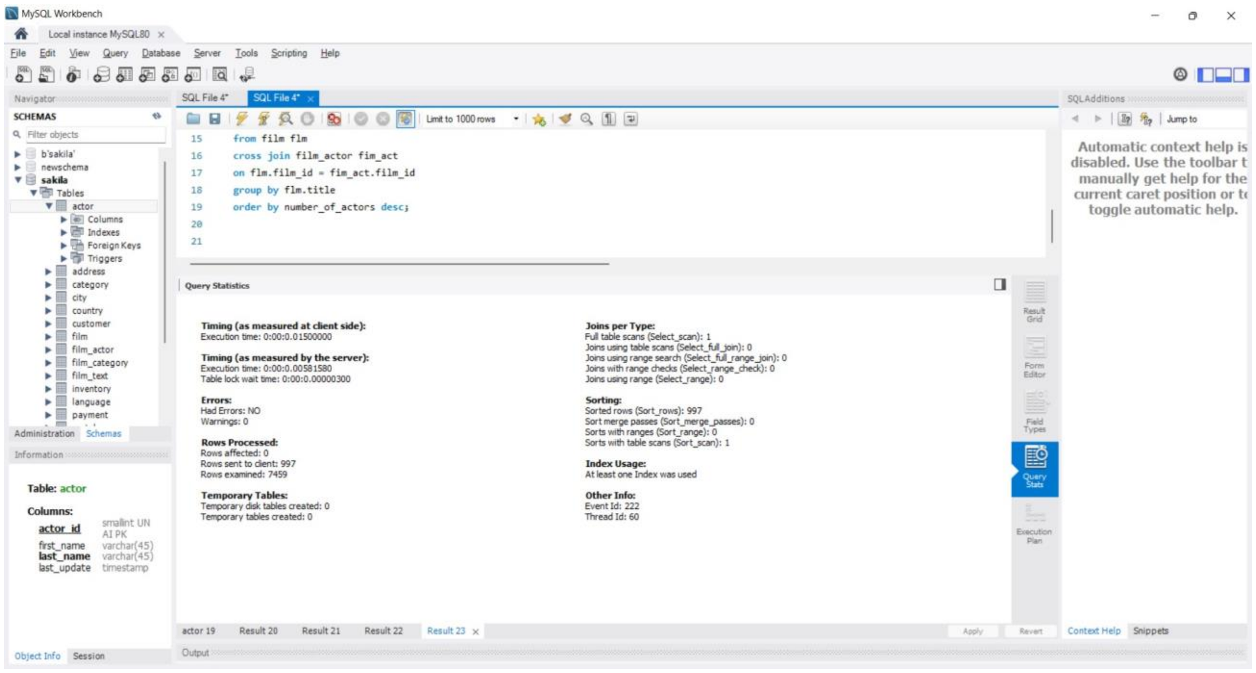
```
Timing (as measured at client side):
Execution time: 0:00:0.18800000

Timing (as measured by the server):
Execution time: 0:00:0.17838100
Table lock wait time: 0:00:0.00006000

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 0
Rows examined: 0

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 293
Thread Id: 60
```

6) CROSS JOIN



```
from film flm
cross join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

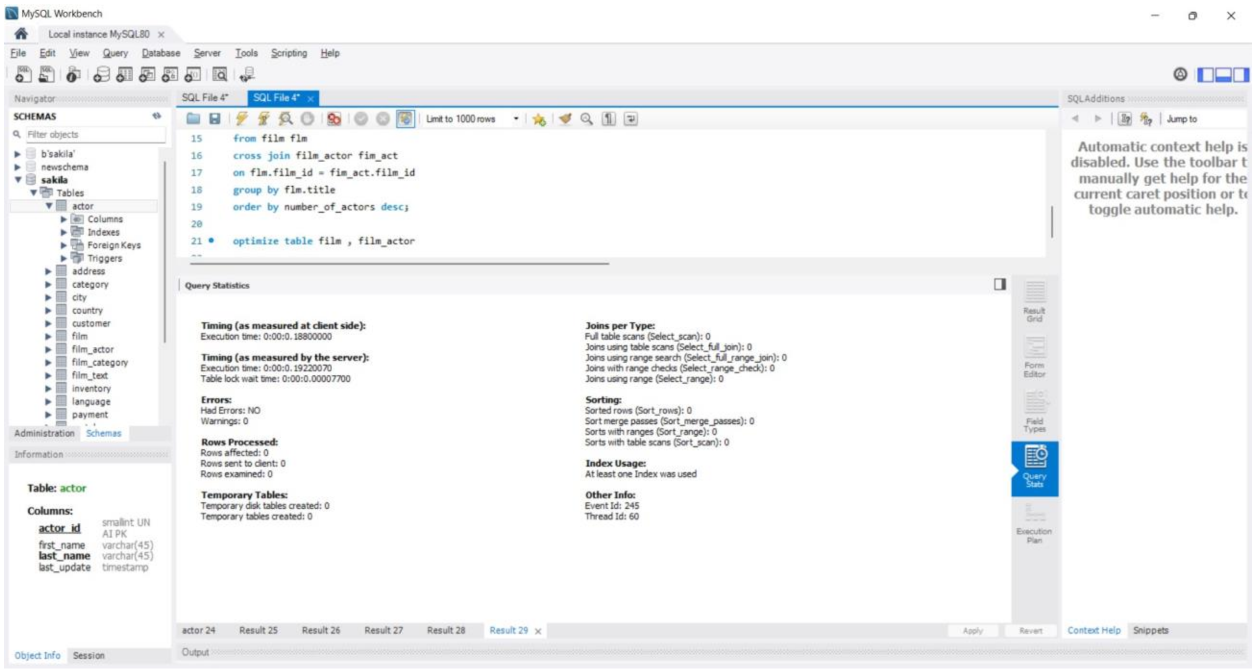
BEFORE OPTIMIZING



```
from film flm
cross join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

```
Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.01500000

Timing (as measured by the server):
Execution time: 0:00:0.00581580
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 997
Rows examined: 7459

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 997
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 1

Index Usage:
At least one Index was used

Other Info:
Event Id: 222
Thread Id: 60
```

AFTER OPTIMIZING

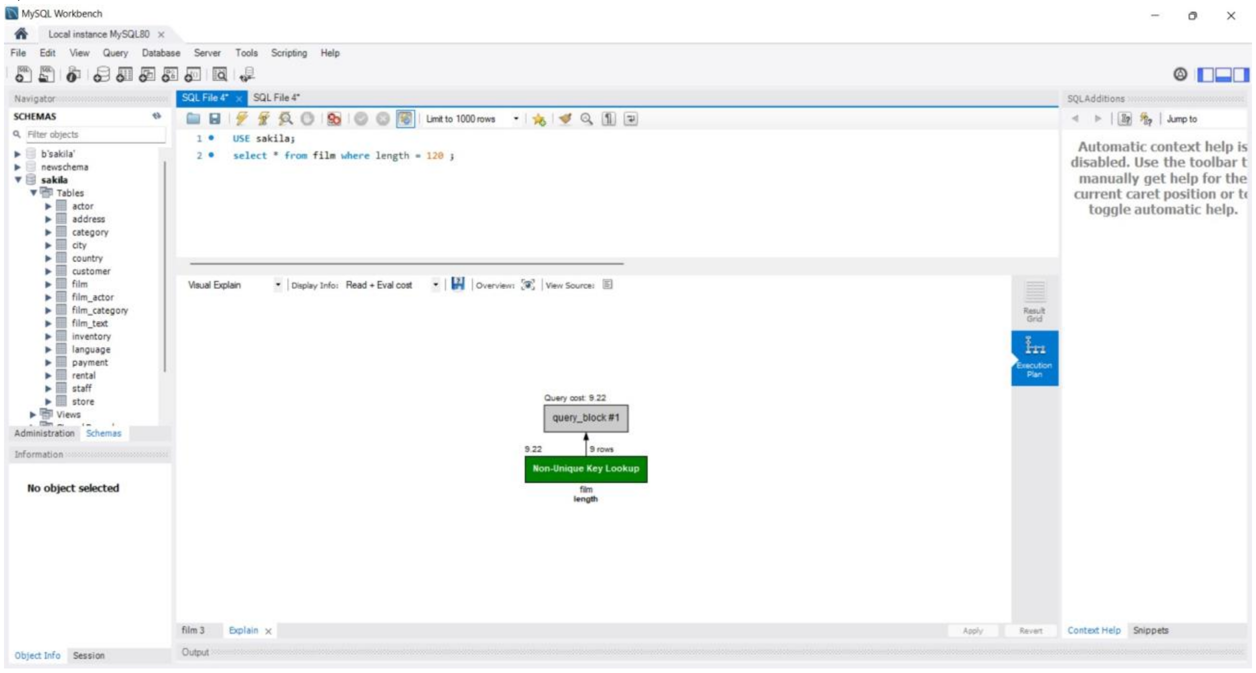


```
from film flm
cross join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;

optimize table film , film_actor
```

```
Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.18800000

Timing (as measured by the server):
Execution time: 0:00:0.19220070
Table lock wait time: 0:00:0.00007700

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 0
Rows examined: 0

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 245
Thread Id: 60
```

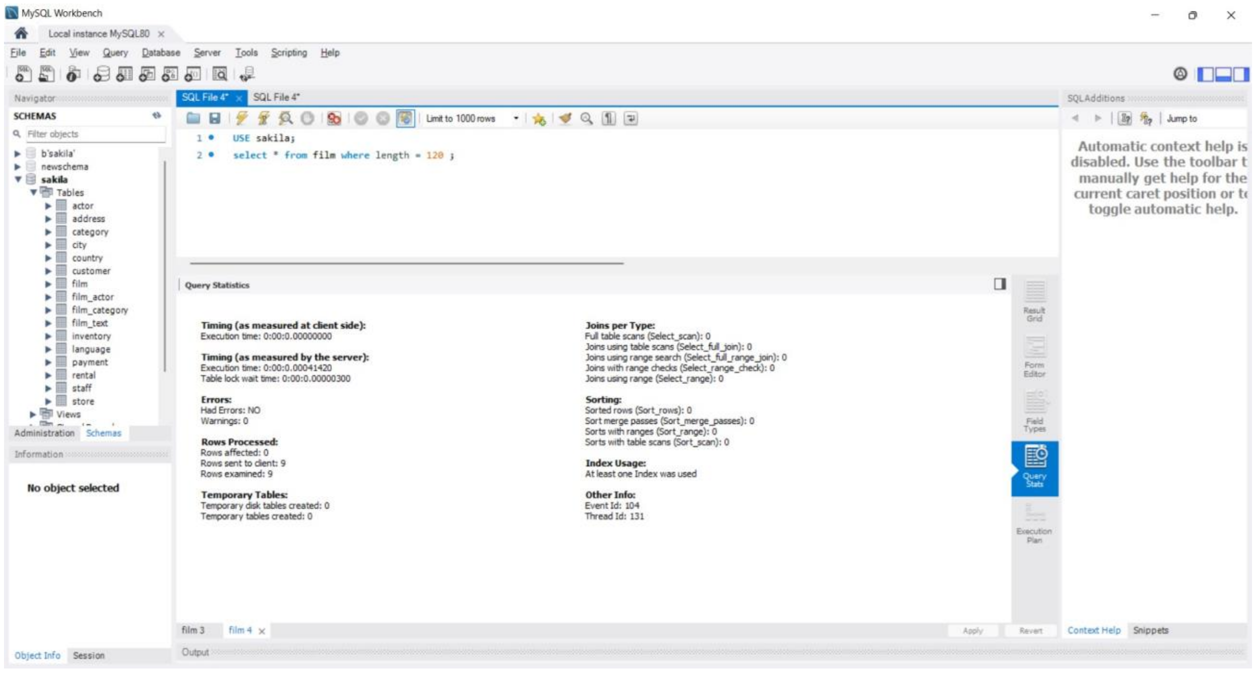
USING INDEXING

1)SIMPLE QUERY



```
USE sakila;
select * from film where length = 120 ;
```

BEFORE INDEXING



```
USE sakila;
select * from film where length = 120 ;
```

Query Statistics

Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00041420
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 9
Rows examined: 9

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

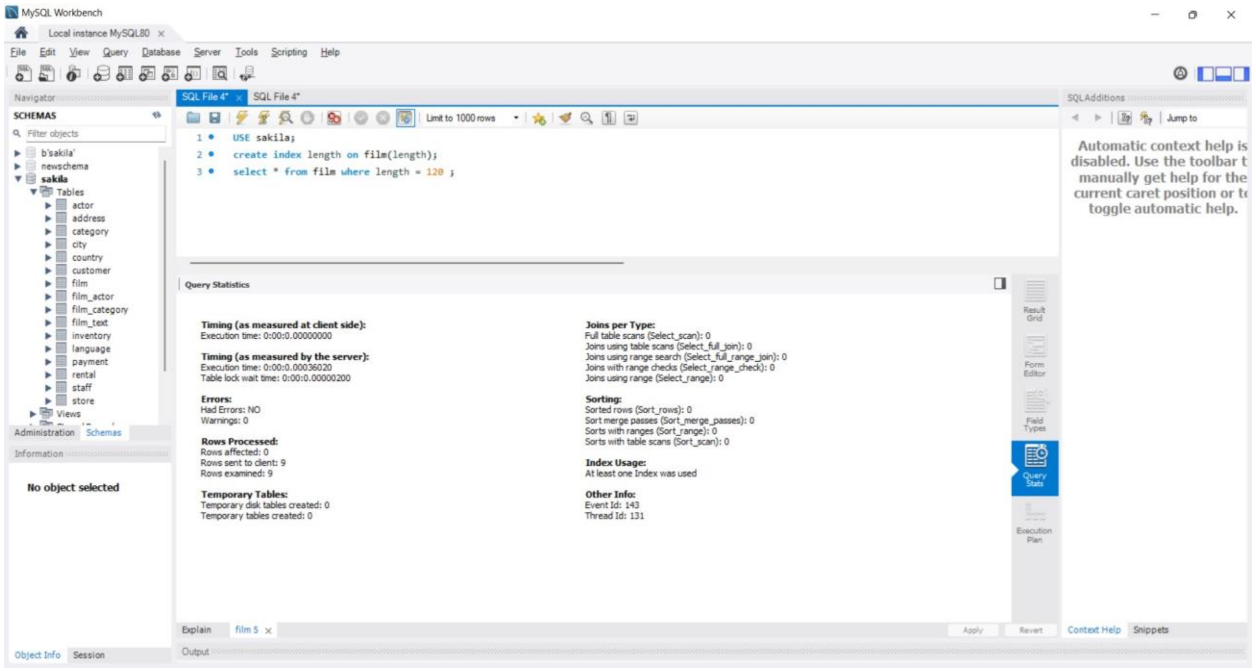
Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 104
Thread Id: 131

AFTER INDEXING

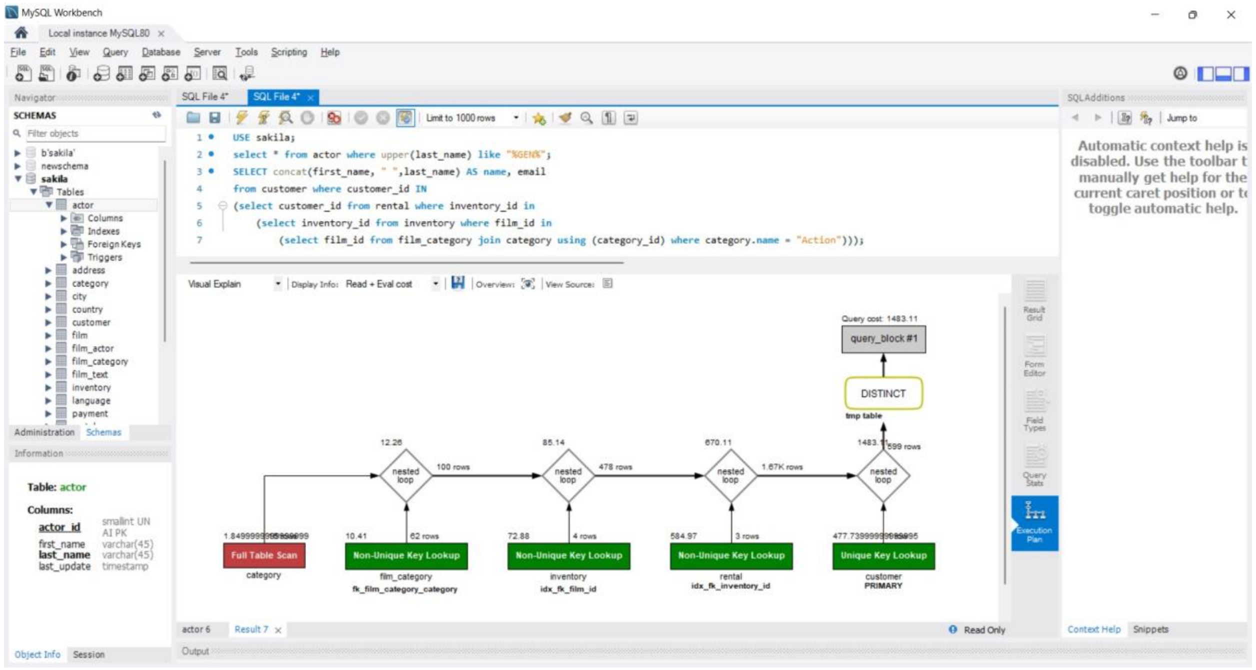


```
USE sakila;
create index length on film(length);
select * from film where length = 120 ;
```

Query Statistics

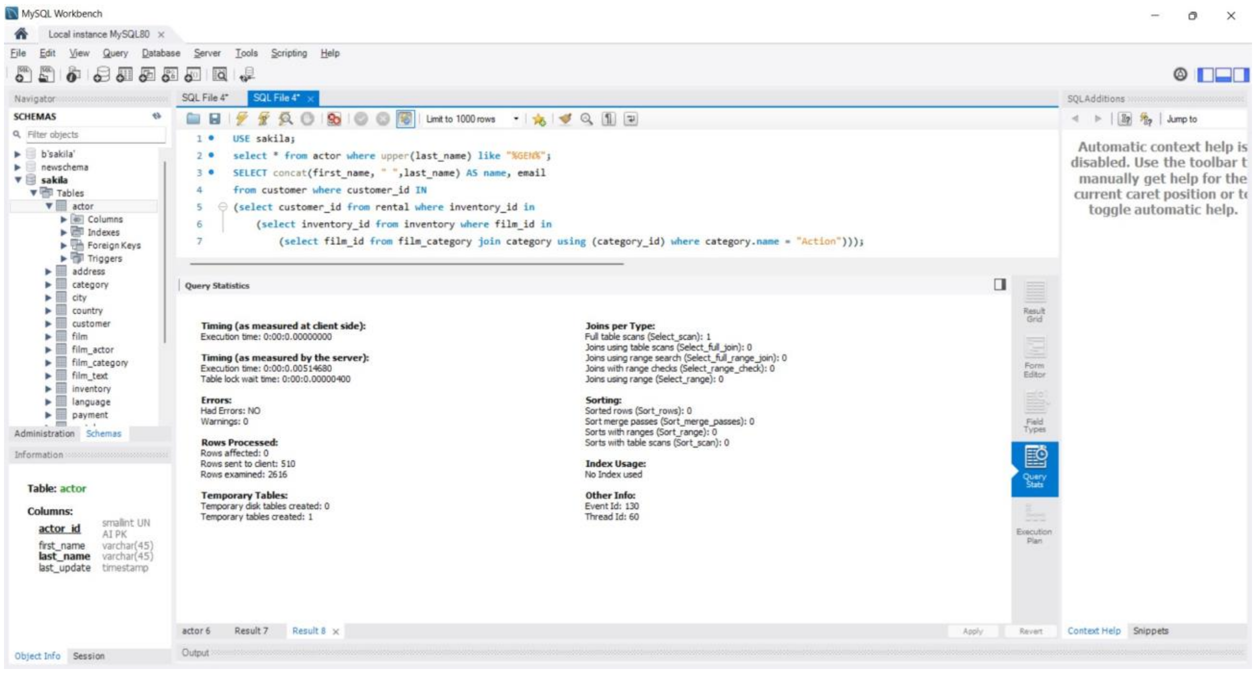
```
Timing (as measured at client side):
Execution time: 0:00:0.00000000

Timing (as measured by the server):
Execution time: 0:00:0.00036020
Table lock wait time: 0:00:0.00000200

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 9
Rows examined: 9

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 0

Joins per Type:
Full table scans (Select_scan): 0
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 0
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 0

Index Usage:
At least one Index was used

Other Info:
Event Id: 143
Thread Id: 131
```

2) NESTED



```
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
SELECT concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));
```

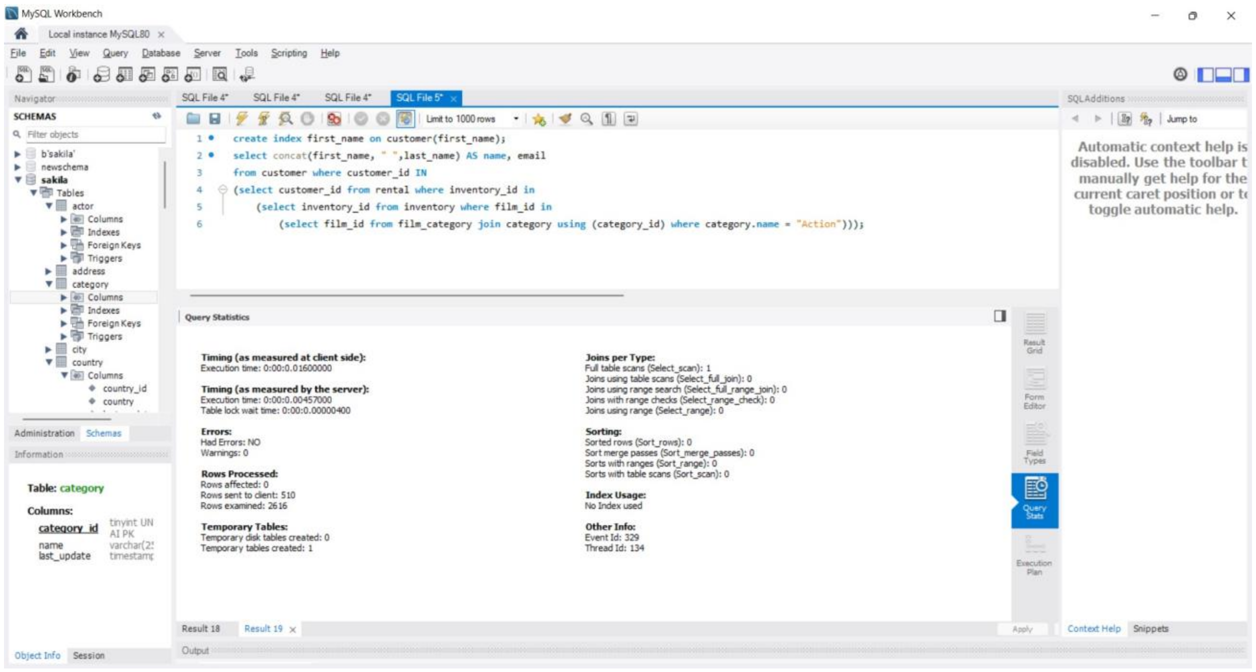
BEFORE INDEXING



```
USE sakila;
select * from actor where upper(last_name) like "%GEN%";
SELECT concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));
```

```
Query Statistics

Timing (as measured at client side):        Joins per Type:
Execution time: 0:00:0.00000000             Full table scans (Select_scan): 1
                                            Joins using table scans (Select_full_join): 0
Timing (as measured by the server):         Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.00514680             Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00000400       Joins using range (Select_range): 0

Errors:                                     Sorting:
Had Errors: NO                              Sorted rows (Sort_rows): 0
Warnings: 0                                 Sort merge passes (Sort_merge_passes): 0
                                            Sorts with ranges (Sort_range): 0
Rows Processed:                             Sorts with table scans (Sort_scan): 0
Rows affected: 0
Rows sent to client: 510                    Index Usage:
Rows examined: 2616                         No Index used

Temporary Tables:                           Other Info:
Temporary disk tables created: 0            Event Id: 130
Temporary tables created: 1                 Thread Id: 60
```

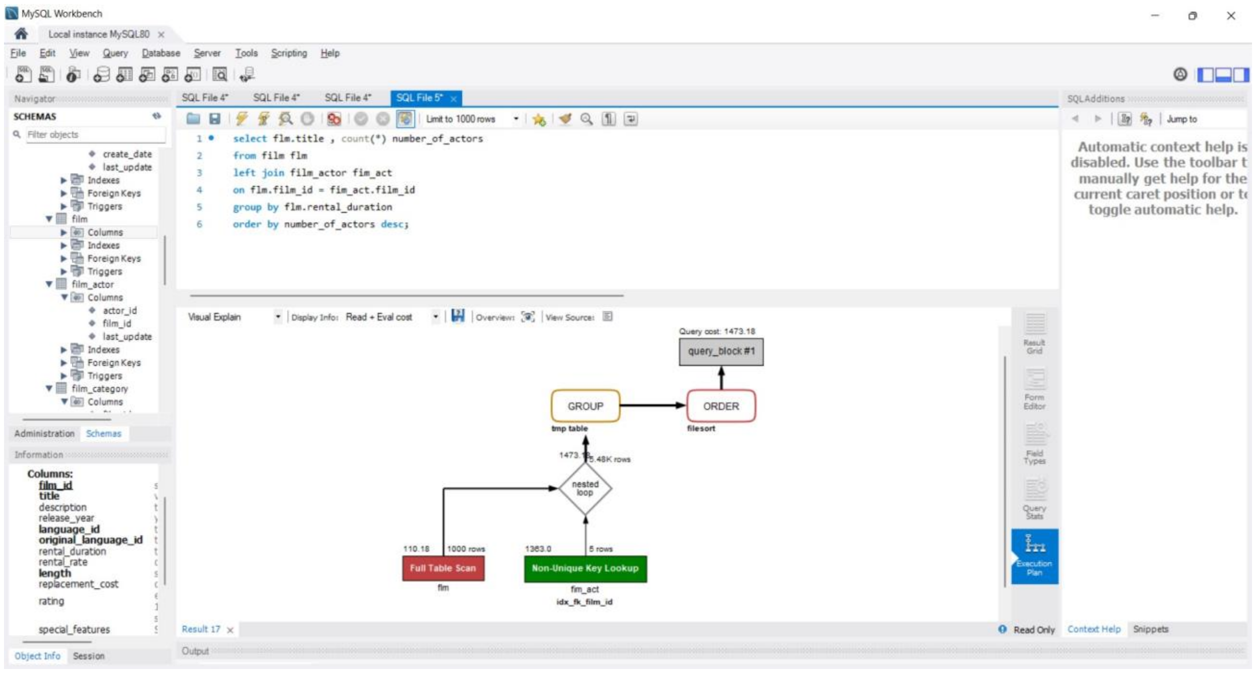
AFTER INDEXING



```
create index first_name on customer(first_name);
select concat(first_name, " ",last_name) AS name, email
from customer where customer_id IN
(select customer_id from rental where inventory_id in
    (select inventory_id from inventory where film_id in
        (select film_id from film_category join category using (category_id) where category.name = "Action")));
```

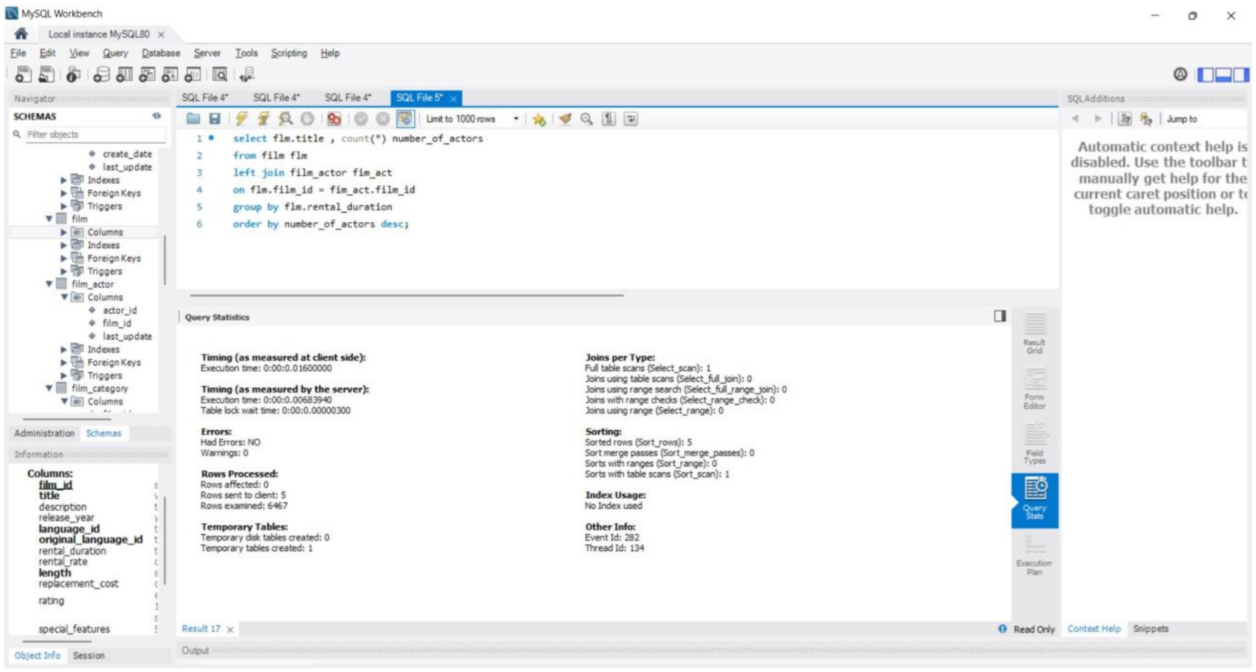
```
Query Statistics

Timing (as measured at client side):        Joins per Type:
Execution time: 0:00:0.01600000             Full table scans (Select_scan): 1
                                            Joins using table scans (Select_full_join): 0
Timing (as measured by the server):         Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.00457000             Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00000400       Joins using range (Select_range): 0

Errors:                                     Sorting:
Had Errors: NO                              Sorted rows (Sort_rows): 0
Warnings: 0                                 Sort merge passes (Sort_merge_passes): 0
                                            Sorts with ranges (Sort_range): 0
Rows Processed:                             Sorts with table scans (Sort_scan): 0
Rows affected: 0
Rows sent to client: 510                    Index Usage:
Rows examined: 2616                         No Index used

Temporary Tables:                           Other Info:
Temporary disk tables created: 0            Event Id: 329
Temporary tables created: 1                 Thread Id: 134
```

3) LEFT JOIN



```sql
select flm.title , count(*) number_of_actors
from film flm
left join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.rental_duration
order by number_of_actors desc;
```

BEFORE INDEXING

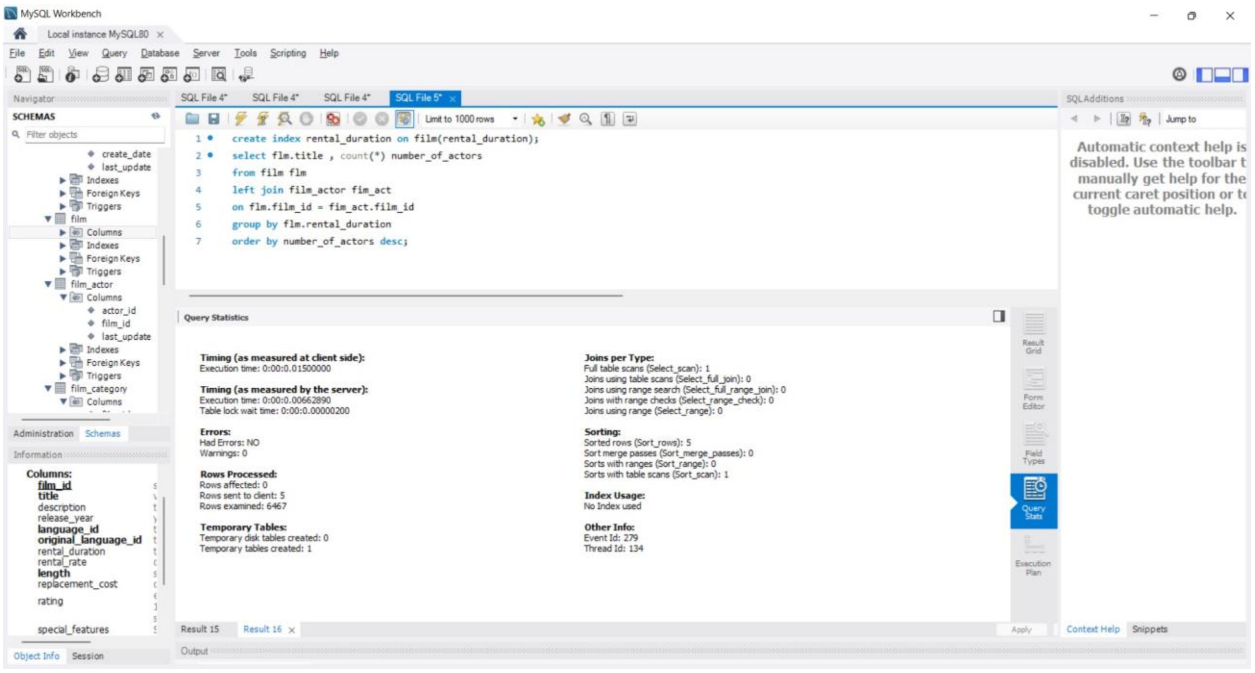


```sql
select flm.title , count(*) number_of_actors
from film flm
left join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.rental_duration
order by number_of_actors desc;
```

Query Statistics

```
Timing (as measured at client side):
Execution time: 0:00:0.01600000

Timing (as measured by the server):
Execution time: 0:00:0.00683940
Table lock wait time: 0:00:0.00000300

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 5
Rows examined: 6467

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 1

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 5
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 1

Index Usage:
No Index used

Other Info:
Event Id: 282
Thread Id: 134
```

AFTER INDEXING

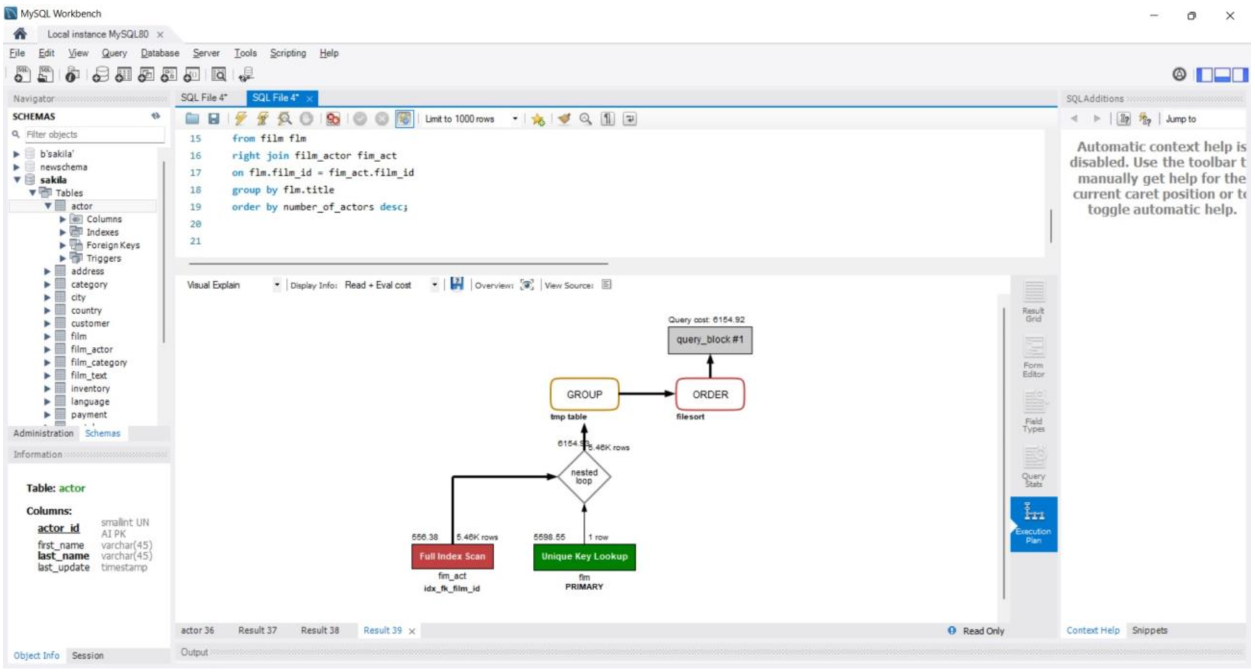


```sql
create index rental_duration on film(rental_duration);
select flm.title , count(*) number_of_actors
from film flm
left join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.rental_duration
order by number_of_actors desc;
```

Query Statistics

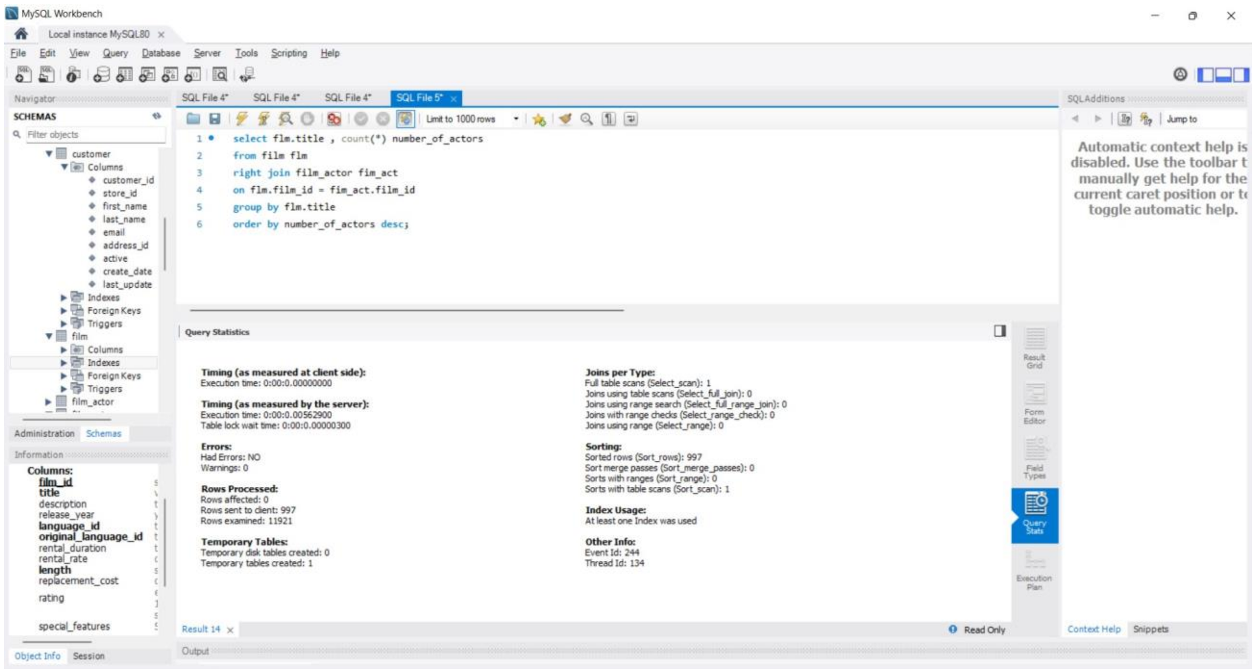
```
Timing (as measured at client side):
Execution time: 0:00:0.01500000

Timing (as measured by the server):
Execution time: 0:00:0.00662890
Table lock wait time: 0:00:0.00000200

Errors:
Had Errors: NO
Warnings: 0

Rows Processed:
Rows affected: 0
Rows sent to client: 5
Rows examined: 6467

Temporary Tables:
Temporary disk tables created: 0
Temporary tables created: 1

Joins per Type:
Full table scans (Select_scan): 1
Joins using table scans (Select_full_join): 0
Joins using range search (Select_full_range_join): 0
Joins with range checks (Select_range_check): 0
Joins using range (Select_range): 0

Sorting:
Sorted rows (Sort_rows): 5
Sort merge passes (Sort_merge_passes): 0
Sorts with ranges (Sort_range): 0
Sorts with table scans (Sort_scan): 1

Index Usage:
No Index used

Other Info:
Event Id: 279
Thread Id: 134
```

4) RIGHT JOIN



```sql
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

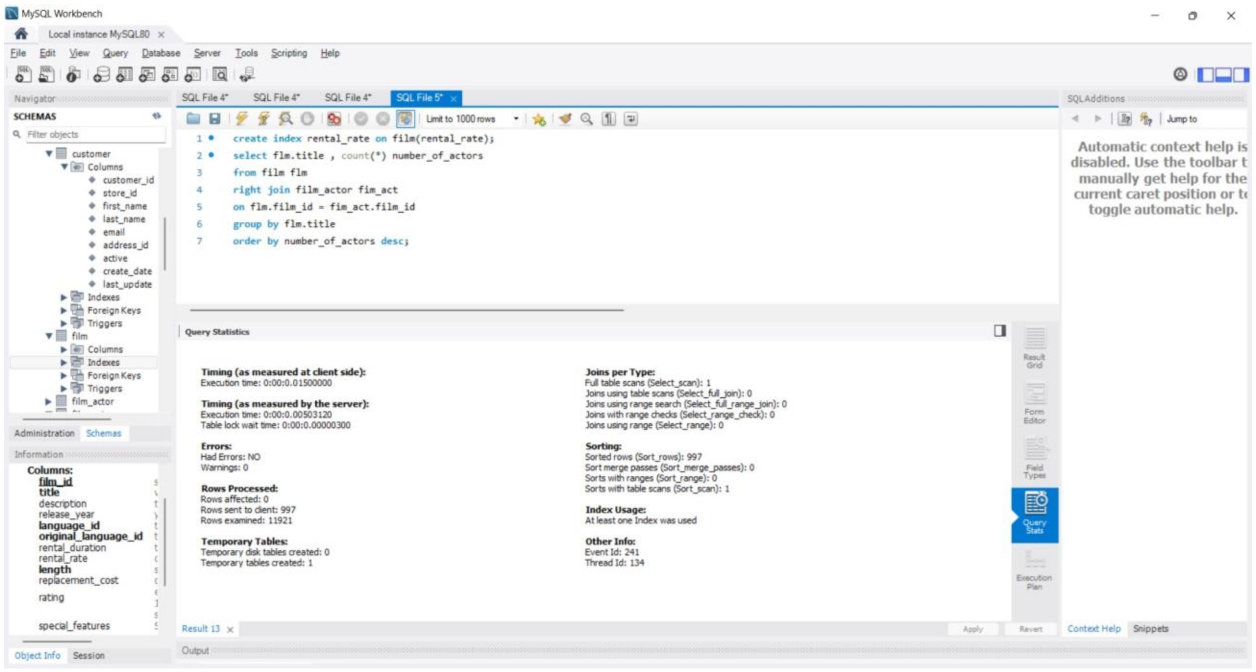
BEFORE INDEXING



```sql
select flm.title , count(*) number_of_actors
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

```
Query Statistics

Timing (as measured at client side):              Joins per Type:
Execution time: 0:00:0.00000000                   Full table scans (Select_scan): 1
                                                  Joins using table scans (Select_full_join): 0
Timing (as measured by the server):               Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.00562900                   Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00000300             Joins using range (Select_range): 0

Errors:                                           Sorting:
Had Errors: NO                                    Sorted rows (Sort_rows): 997
Warnings: 0                                       Sort merge passes (Sort_merge_passes): 0
                                                  Sorts with ranges (Sort_range): 0
Rows Processed:                                   Sorts with table scans (Sort_scan): 1
Rows affected: 0
Rows sent to client: 997                          Index Usage:
Rows examined: 11921                              At least one Index was used

Temporary Tables:                                 Other Info:
Temporary disk tables created: 0                  Event Id: 244
Temporary tables created: 1                       Thread Id: 134
```

AFTER INDEXING



```sql
create index rental_rate on film(rental_rate);
select flm.title , count(*) number_of_actors
from film flm
right join film_actor fim_act
on flm.film_id = fim_act.film_id
group by flm.title
order by number_of_actors desc;
```

```
Query Statistics

Timing (as measured at client side):              Joins per Type:
Execution time: 0:00:0.01500000                   Full table scans (Select_scan): 1
                                                  Joins using table scans (Select_full_join): 0
Timing (as measured by the server):               Joins using range search (Select_full_range_join): 0
Execution time: 0:00:0.00503120                   Joins with range checks (Select_range_check): 0
Table lock wait time: 0:00:0.00000300             Joins using range (Select_range): 0

Errors:                                           Sorting:
Had Errors: NO                                    Sorted rows (Sort_rows): 997
Warnings: 0                                       Sort merge passes (Sort_merge_passes): 0
                                                  Sorts with ranges (Sort_range): 0
Rows Processed:                                   Sorts with table scans (Sort_scan): 1
Rows affected: 0
Rows sent to client: 997                          Index Usage:
Rows examined: 11921                              At least one Index was used

Temporary Tables:                                 Other Info:
Temporary disk tables created: 0                  Event Id: 241
Temporary tables created: 1                       Thread Id: 134
```