

# **MySQL Query Analysis and Optimization**

Michael Moussa

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# About Me

- Web application developer for 17 years
- Solutions Architect at  **rackspace**<sup>®</sup>  
the #1 managed cloud company
- Zend Expressive maintainer & general open source contributor



5.7

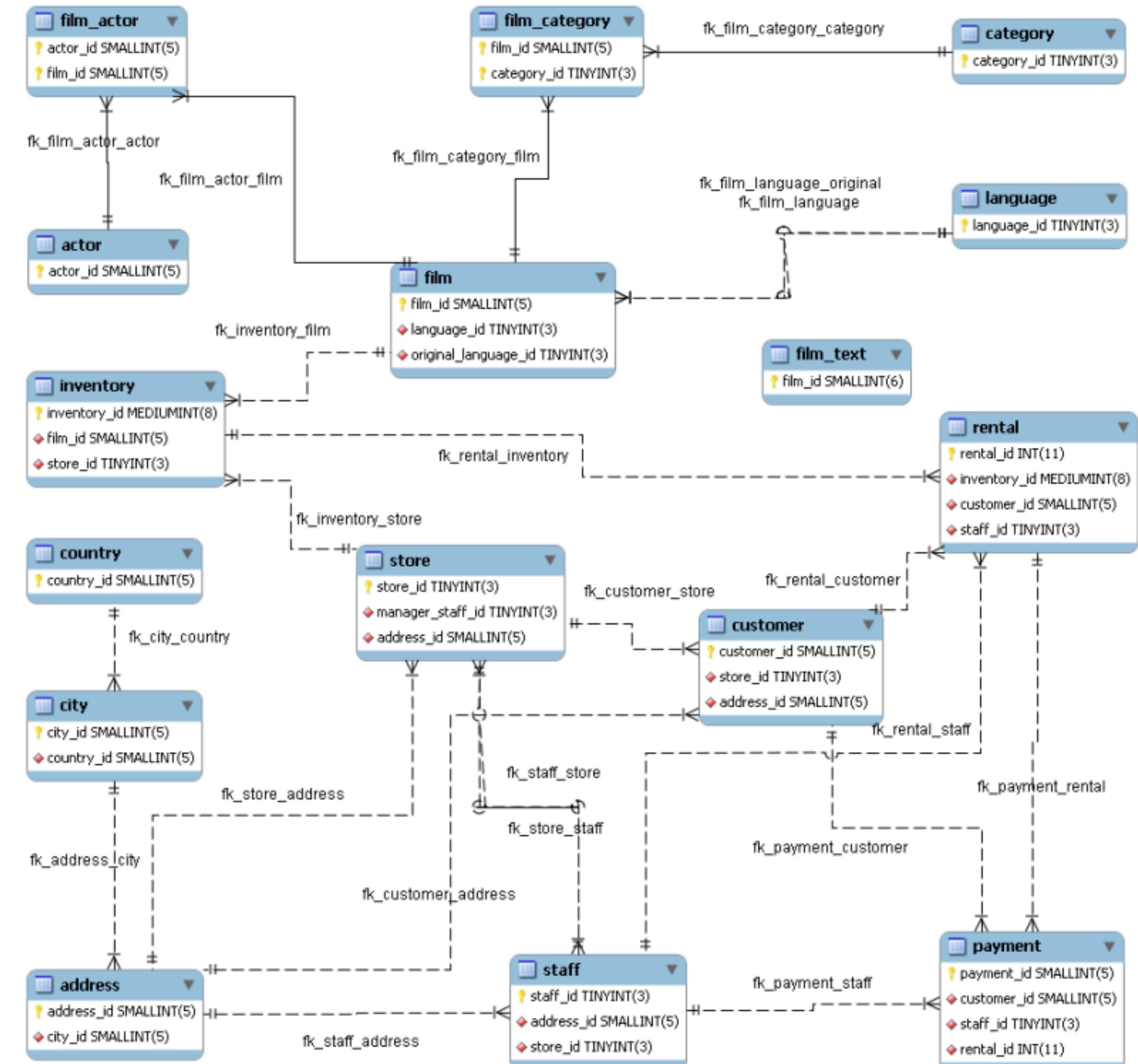
<https://dev.mysql.com/downloads/mysql/>

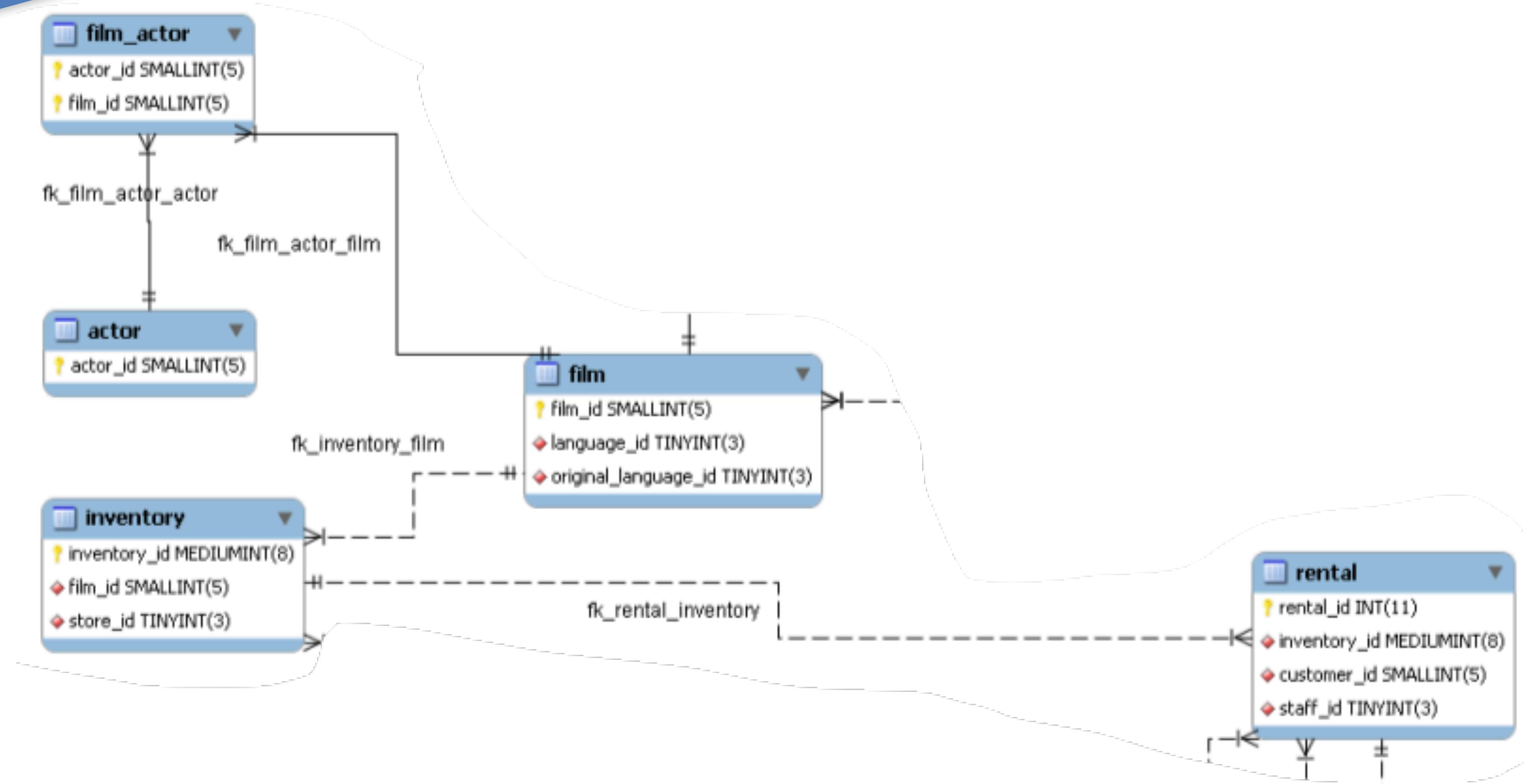
# Sakila Sample Database

```
mysql> SOURCE /path/to/sakila-schema.sql
```

```
mysql> SOURCE /path/to/sakila-data.sql
```

<https://dev.mysql.com/doc/sakila/en/>





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SELECT * FROM film  
WHERE rating = 'PG-13'  
ORDER BY title;
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- How good is the server?

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# Query Execution Plan

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film_id	title	length	rental_rate	replacement_cost	rating	description
1	Astro City	115	0.99	12.99	PG-13	Sci-fi movie about a city where people live in space.
2	Beyond the Stars	120	0.99	12.99	PG-13	Sci-fi movie about a journey through the stars.
3	Cosmos: A Space Odyssey	130	0.99	12.99	PG-13	Sci-fi movie about the search for extraterrestrial life.
4	Galaxy War	140	0.99	12.99	PG-13	Sci-fi movie about a war between Earth and the galaxy.
5	Interstellar	150	0.99	12.99	PG-13	Sci-fi movie about a mission to save humanity.
6	Star Trek	160	0.99	12.99	PG-13	Sci-fi movie about a crew of starship officers.
7	Star Wars: Episode IV - A New Hope	170	0.99	12.99	PG-13	Sci-fi movie about a young Jedi knight.
8	Star Wars: Episode V - The Empire Strikes Back	180	0.99	12.99	PG-13	Sci-fi movie about a return to the Empire.
9	Star Wars: Episode VI - Return of the Jedi	190	0.99	12.99	PG-13	Sci-fi movie about the final battle of the Empire.
10	Star Wars: Episode VII - The Force Awakens	200	0.99	12.99	PG-13	Sci-fi movie about a new generation of Jedi.
11	Star Wars: Episode VIII - The Last Jedi	210	0.99	12.99	PG-13	Sci-fi movie about the final confrontation.
12	Star Wars: Episode IX - The Rise of Skywalker	220	0.99	12.99	PG-13	Sci-fi movie about the final chapter of the Skywalker saga.
13	Star Trek Beyond	130	0.99	12.99	PG-13	Sci-fi movie about a new adventure.
14	Star Trek Into Darkness	140	0.99	12.99	PG-13	Sci-fi movie about a new threat.
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id	parent_id	label	estimated_cost	estimated_size	estimated_time	estimated_parallelism	estimated_parallel_workers
1		Root	1000.00	1000.00	1000.00	1	1
2	1	TableScan(film)	1000.00	1000.00	1000.00	1	1
3	2	Filter(rating = 'PG-13')	1000.00	1000.00	1000.00	1	1
4	3	Sort(title)	1000.00	1000.00	1000.00	1	1
5	4	Output	1000.00	1000.00	1000.00	1	1

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```



id	parent_id	label	order	cost	rows	estimated_cost	estimated_rows	table_name	table_alias
1		SELECT	1	0.00	1	0.00	1		
2	1	*	2	0.00	1	0.00	1		
3	1	FROM	3	0.00	1	0.00	1		
4	3	film	4	0.00	1	0.00	1		
5	1	WHERE	5	0.00	1	0.00	1		
6	5	rating = 'PG-13'	6	0.00	1	0.00	1		
7	1	ORDER BY	7	0.00	1	0.00	1		
8	7	title	8	0.00	1	0.00	1		

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```
EXPLAIN SELECT * FROM film
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```

<code>id</code>	<code>select_type</code>	<code>table</code>	<code>partitions</code>	<code>type</code>	<code>possible_keys</code>	<code>key</code>	<code>key_len</code>	<code>ref</code>	<code>rows</code>	<code>filtered</code>	<code>Extra</code>
1	<code>SIMPLE</code>	film	NULL	ALL	NULL	NULL	NULL	NULL	1000	20.00	<code>Using where; Using filesort</code>


select_type
SIMPLE

	table	
	film	

	partitions	
	NULL	

	+ - - - - +
	<b>type</b>
	+ - - - - +
	<b>ALL</b>
	+ - - - - +

possible_keys
NULL

	+-----+
	key
	+-----+
	NULL
	+-----+

	key_len	
	NULL	

	+-----+
	<b>ref</b>
	+-----+
	<b>NULL</b>
	+-----+

	+	-	-	-	-	+
			rows			
	+	-	-	-	-	+
			1000			
	+	-	-	-	-	+

filtered

+-----+  
| Extra |  
+-----+  
| Using where; Using filesort |  
+-----+

<code>id</code>	<code>select_type</code>	<code>table</code>	<code>partitions</code>	<code>type</code>	<code>possible_keys</code>	<code>key</code>	<code>key_len</code>	<code>ref</code>	<code>rows</code>	<code>filtered</code>	<code>Extra</code>
1	<code>SIMPLE</code>	film	NULL	ALL	NULL	NULL	NULL	NULL	1000	20.00	<code>Using where; Using filesort</code>

<code>id</code>	<code>select_type</code>	<code>table</code>	<code>partitions</code>	<code>type</code>	<code>possible_keys</code>	<code>key</code>	<code>key_len</code>	<code>ref</code>	<code>rows</code>	<code>filtered</code>	<code>Extra</code>
1	SIMPLE	film	NULL	ALL	NULL	NULL	NULL	NULL	1000	20.00	Using where; Using filesort

<del>id</del>	<del>select_type</del>	<del>table</del>	<del>partitions</del>	<del>type</del>	<del>possible_keys</del>	<del>key</del>	<del>key_len</del>	<del>ref</del>	<del>rows</del>	<del>filtered</del>	<del>Extra</del>
1	SIMPLE	film	NULL	ALL	NULL	NULL	NULL	NULL	1000	20.00	Using where; Using filesort

type	possible_keys	key	key_len	ref
ALL	NULL	NULL	NULL	NULL

rows	Extra
1000	Using where; Using filesort

type	possible_keys	key	key_len	ref
ALL	NULL	NULL	NULL	NULL

rows	Extra
1000	Using where; Using filesort

id	name	street_address	city	state	zip_code	phone
1	Franco, Karen	Ap #755-4742 Facilisis St.	Springfield	MO	43416	(106) 849-6533
2	Spears, Kasper	P.O. Box 735, 4334 Odio Av.	Chesapeake	VA	98479	(575) 628-4700
3	Hammond, Eagan	Ap #144-8093 Sed St.	Ketchikan	AK	99976	(449) 141-4138
4	Snider, Nell	371-9283 Quis Street	Dover	DE	43469	(396) 685-6187
5	Castillo, Warren	Ap #168-6393 Duis Rd.	Helena	MT	55870	(161) 613-0189
6	Wolf, Kaden	Ap #715-9286 Iaculis Rd.	Provo	UT	52417	(629) 431-4616
7	Delacruz, Demetrius	Ap #849-1764 Tortor Road	Lakewood	CO	28653	(822) 996-8301
8	Juarez, Doris	868-7573 Nisi Rd.	Portland	OR	75494	(467) 118-7614
9	Wilder, Nita	Ap #998-9604 Gravida. Road	Oklahoma City	OK	78281	(941) 150-6649
10	Contreras, Zeus	P.O. Box 331, 7240 Mi Street	Mesa	AZ	85355	(328) 770-3052
11	Hale, Deborah	9894 Blandit St.	Evansville	IN	58950	(984) 274-5023
12	Simon, Christopher	310-7500 Odio. Ave	Saint Paul	MN	92020	(467) 702-3457
13	Johns, Grady	3624 Id St.	Little Rock	AR	71837	(237) 999-9658
14	Leblanc, Ifeoma	410-7139 Aliquam, Rd.	Hillsboro	OR	28131	(718) 104-3022
15	Tyson, Zeph	5159 Ac Avenue	Covington	KY	65803	(736) 889-3502
16	Mckenzie, Mercedes	P.O. Box 344, 8895 Ridiculus St.	Olathe	KS	71691	(503) 884-5285
17	Baxter, Nelle	924-9300 Fames Av.	Houston	TX	21327	(713) 684-9391
18	Keller, Elaine	594-3184 Dapibus Rd.	Gillette	WY	43817	(494) 518-0997
19	Logan, Alec	Ap #560-6087 Id St.	Phoenix	AZ	86132	(184) 507-3231
20	Christensen, Mona	P.O. Box 948, 3731 Dui Avenue	Virginia Beach	VA	73884	(469) 792-9473

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12	Simon, Christopher	310-7500 Odio. Ave	Saint Paul	MN	92020	(467) 702-3457
13	Johns, Grady	3624 Id St.	Little Rock	AR	71837	(237) 999-9658
14	Leblanc, Ifeoma	410-7139 Aliquam, Rd.	Hillsboro	OR	28131	(718) 104-3022
15	Tyson, Zeph	5159 Ac Avenue	Covington	KY	65803	(736) 889-3502
16	Mckenzie, Mercedes	P.O. Box 344, 8895 Ridiculus St.	Olathe	KS	71691	(503) 884-5285
17	Baxter, Nelle	924-9300 Fames Av.	Houston	TX	21327	(713) 684-9391
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7	Delacruz, Demetrius	Ap #849-1764 Tortor Road	Lakewood	CO	28653	(822) 996-8301
8	Juarez, Doris	868-7573 Nisi Rd.	Portland	OR	75494	(467) 118-7614
9	Wilder, Nita	Ap #998-9604 Gravida. Road	Oklahoma City	OK	78281	(941) 150-6649
10	Contreras, Zeus	P.O. Box 331, 7240 Mi Street	Mesa	AZ	85355	(328) 770-3052
11	Hale, Deborah	9894 Blandit St.	Evansville	IN	58950	(984) 274-5023
12	Simon, Christopher	310-7500 Odio. Ave	Saint Paul	MN	92020	(467) 702-3457
13	Johns, Grady	3624 Id St.	Little Rock	AR	71837	(237) 999-9658
14	Leblanc, Ifeoma	410-7139 Aliquam, Rd.	Hillsboro	OR	28131	(718) 104-3022
15	Tyson, Zeph	5159 Ac Avenue	Covington	KY	65803	(736) 889-3502
16	Mckenzie, Mercedes	P.O. Box 344, 8895 Ridiculus St.	Olathe	KS	71691	(503) 884-5285
17	Baxter, Nelle	924-9300 Fames Av.	Houston	TX	21327	(713) 684-9391
18	Keller, Elaine	594-3184 Dapibus Rd.	Gillette	WY	43817	(494) 518-0997
19	Logan, Alec	Ap #560-6087 Id St.	Phoenix	AZ	86132	(184) 507-3231
20	Christensen, Mona	P.O. Box 948, 3731 Dui Avenue	Virginia Beach	VA	73884	(469) 792-9473

id	name	street_address	city	state	zip_code	phone
1	Franco, Karen	Ap #755-4742 Facilisis St.	Springfield	MO	43416	(106) 849-6533
2	Spears, Kasper	P.O. Box 735, 4334 Odio Av.	Chesapeake	VA	98479	(575) 628-4700
3	Hammond, Eagan	Ap #144-8093 Sed St.	Ketchikan	AK	99976	(449) 141-4138
→  4	Snider, Nell	371-9283 Quis Street	Dover	DE	43469	(396) 685-6187
5	Castillo, Warren	Ap #168-6393 Duis Rd.	Helena	MT	55870	(161) 613-0189
6	Wolf, Kaden	Ap #715-9286 Iaculis Rd.	Provo	UT	52417	(629) 431-4616
7	Delacruz, Demetrius	Ap #849-1764 Tortor Road	Lakewood	CO	28653	(822) 996-8301
8	Juarez, Doris	868-7573 Nisi Rd.	Portland	OR	75494	(467) 118-7614
9	Wilder, Nita	Ap #998-9604 Gravida. Road	Oklahoma City	OK	78281	(941) 150-6649
10	Contreras, Zeus	P.O. Box 331, 7240 Mi Street	Mesa	AZ	85355	(328) 770-3052
11	Hale, Deborah	9894 Blandit St.	Evansville	IN	58950	(984) 274-5023
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13	Johns, Grady	3624 Id St.	Little Rock	AR	71837	(237) 999-9658
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18	Keller, Elaine	594-3184 Dapibus Rd.	Gillette	WY	43817	(494) 518-0997
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16	Mckenzie, Mercedes	P.O. Box 344, 8895 Ridiculus St.	Olathe	KS	71691	(503) 884-5285
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19	Logan, Alec	Ap #560-6087 Id St.	Phoenix	AZ	86132	(184) 507-3231
20	Christensen, Mona	P.O. Box 948, 3731 Dui Avenue	Virginia Beach	VA	73884	(469) 792-9473

```
CREATE INDEX idx_rating  
ON film(rating);
```

+-----+ <th>id</th> <th>select_type</th> <th>table</th> <th>partitions</th> <th>type</th> <th>possible_keys</th> <th>key</th> <th>key_len</th> <th>ref</th> <th>rows</th> <th>filtered</th> <th>Extra</th>	id	select_type	table	partitions	type	possible_keys	key	key_len	ref	rows	filtered	Extra
1   SIMPLE   film   NULL   ref   idx_rating   idx_rating   2   const   223   100.00   Using index condition; Using filesort												

id	select_type	table	partitions	type	possible_keys	key	key_len	ref	rows	filtered	Extra
1	SIMPLE	film	NULL	ref	idx_rating	idx_rating	2	const	223	100.00	Using index condition; Using filesort

type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const

rows	Extra
223	Using index condition; Using filesort

type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const

rows	Extra
223	Using index condition; Using filesort



type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const

rows	Extra
223	Using index condition; Using filesort



type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const

rows
Extra

223	Using index condition; Using filesort
-----	---------------------------------------

type	possible_keys	key	key_len	ref	const
ref	idx_rating	idx_rating	2		const

rows	Extra
223	Using index condition; Using filesort

type	possible_keys	key	key_len	ref	const
ref	idx_rating	idx_rating	2		const

rows	Extra
223	Using index condition; Using filesort

type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const

rows
Extra

223	Using index condition; Using filesort
-----	---------------------------------------

type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const
				
rows Extra				
<b>223</b> Using index condition; Using filesort				

	"type"
ALL	ref_or_null
index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system



ALL  
index  
range  
index\_subquery  
unique\_subquery  
index\_merge

"type"

ref\_or\_null  
fulltext  
ref  
eq\_ref  
const  
system

	"type"
ALL	ref_or_null
→ index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system

+-----+-----+		
id   name		
+-----+-----+		
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4	Snider, Nell	
2	Spears, Kasper	
15	Tyson, Zeph	
9	Wilder, Nita	
6	Wolf, Kaden	

**SELECT name FROM person;**

**SELECT \* FROM person;**

**SELECT name, phone FROM person;**

	id	name
	17	Baxter, Nelle
	5	Castillo, Warren
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	4	Snider, Nell
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"index"

**SELECT name FROM person;**

**SELECT \* FROM person;**

**SELECT name, phone FROM person;**

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	15	Tyson, Zeph
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	6	Wolf, Kaden

"index"

`SELECT name FROM person;`

`SELECT * FROM person;`

"ALL"

`SELECT name, phone FROM person;`

	"type"
ALL	ref_or_null
→ index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system

	"type"
ALL	ref_or_null
index	fulltext
→ range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system

+-----+   id   name +-----+
17   Baxter, Nelle
5   Castillo, Warren
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12   Simon, Christopher
4   Snider, Nell
2   Spears, Kasper
15   Tyson, Zeph
9   Wilder, Nita
6   Wolf, Kaden

```
SELECT * FROM person  
WHERE name BETWEEN 'M' AND 'Z';
```

+-----+   id   name +-----+
17   Baxter, Nelle
5   Castillo, Warren
20   Christensen, Mona
10   Contreras, Zeus
7   Delacruz, Demetrius
1   Franco, Karen
11   Hale, Deborah
3   Hammond, Eagan
13   Johns, Grady
8   Juarez, Doris
18   Keller, Elaine
14   Leblanc, Ifeoma
19   Logan, Alec
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12   Simon, Christopher
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```
SELECT * FROM person  
WHERE name BETWEEN 'M' AND 'Z';
```

+-----+-----+	id   name	+-----+
17	Baxter, Nelle	
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8	Juarez, Doris	
18	Keller, Elaine	
14	Leblanc, Ifeoma	
19	Logan, Alec	
16	Mckenzie, Mercedes	
12	Simon, Christopher	
4	Snider, Nell	
2	Spears, Kasper	
15	Tyson, Zeph	
9	Wilder, Nita	
6	Wolf, Kaden	

```
SELECT * FROM person  
WHERE name BETWEEN 'M' AND 'Z';
```



(>, >=, <, <=, IN( ), etc.)

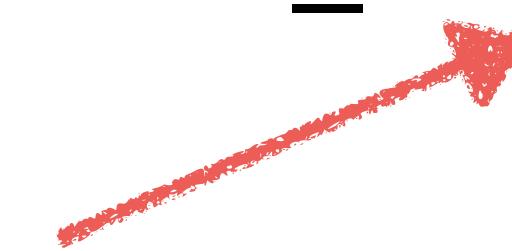
	"type"
ALL	ref_or_null
index	fulltext
→ range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system

	"type"
ALL	ref_or_null
index	fulltext
range	ref
→ index_subquery	eq_ref
→ unique_subquery	const
index_merge	system

	"type"
ALL	ref_or_null
index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
→ index_merge	system

```
SELECT film_id, actor_id  
FROM film_actor  
WHERE actor_id = 13 OR film_id = 13;
```

```
SELECT film_id, actor_id  
FROM film_actor  
WHERE actor_id = 13 OR film_id = 13;
```



35 rows

```
SELECT film_id, actor_id  
FROM film_actor  
WHERE actor_id = 13 OR film_id = 13;
```

35 rows

5 rows

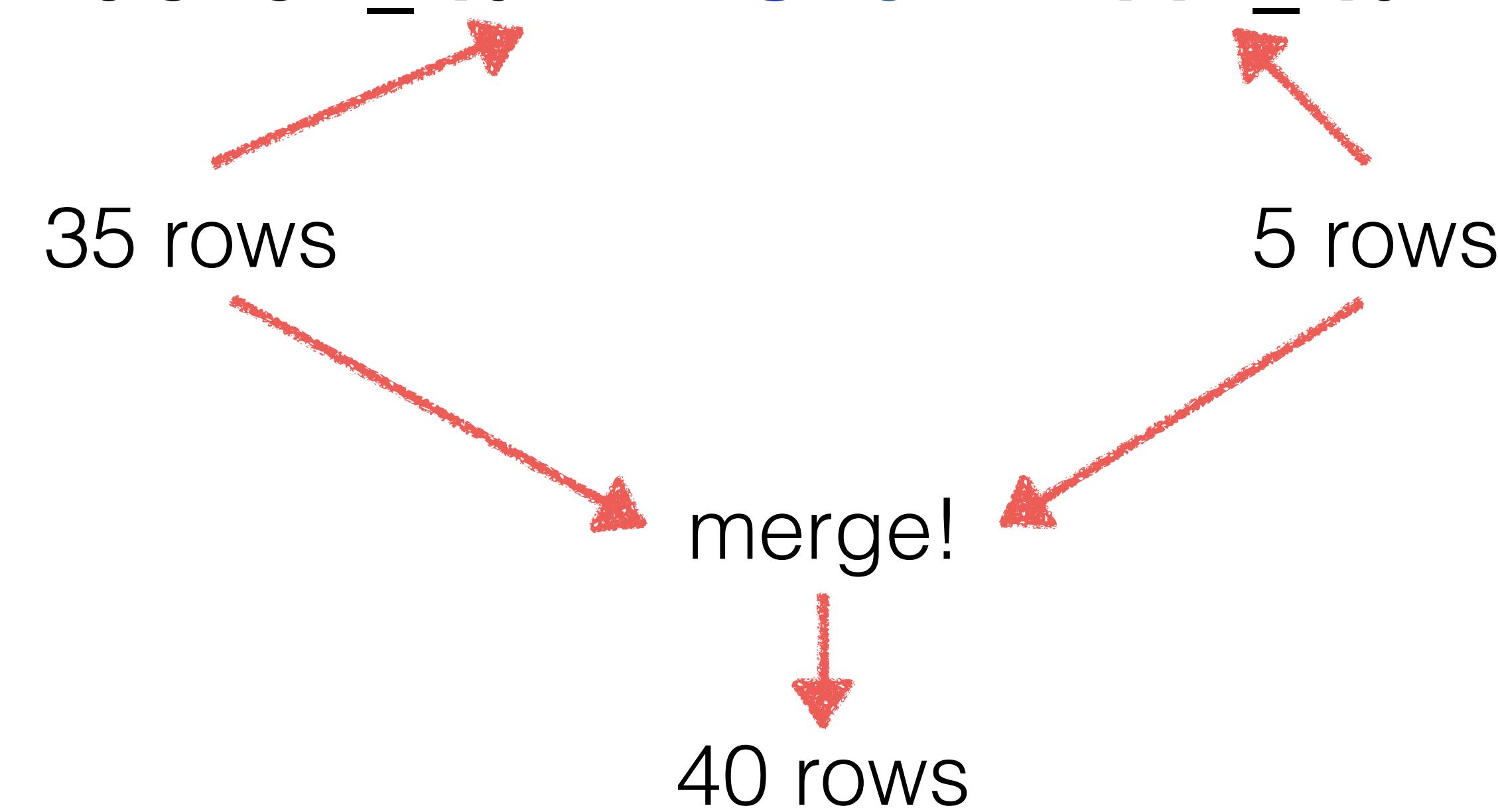
```
SELECT film_id, actor_id  
FROM film_actor  
WHERE actor_id = 13 OR film_id = 13;
```

35 rows

5 rows

merge!

```
SELECT film_id, actor_id  
FROM film_actor  
WHERE actor_id = 13 OR film_id = 13;
```



	"type"
ALL	ref_or_null
index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
→ index_merge	system

ALL  
index  
range  
index\_subquery  
unique\_subquery  
index\_merge

"type"



ref\_or\_null  
fulltext  
ref  
eq\_ref  
const  
system

	"type"
ALL	ref_or_null
index	fulltext
range	ref
index_subquery	eq_ref
unique_subquery	const
index_merge	system

	"type"
ALL	→ ref_or_null
index	fulltext
range	→ ref
index_subquery	→ eq_ref
unique_subquery	→ const
index_merge	system

"const"

```
SELECT * FROM film  
WHERE film_id = 123;
```

"const"

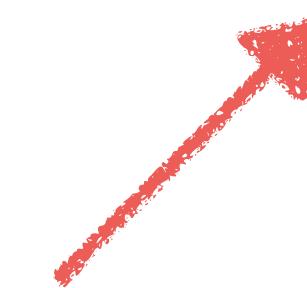
```
SELECT * FROM film  
WHERE film_id = 123;
```



*constant*

"const"

```
SELECT * FROM film  
WHERE film_id = 123;
```



PRIMARY KEY,  
so one possible value



**constant**

"ref"

```
SELECT * FROM film
WHERE rating = 'PG-13';
```

"ref"

```
SELECT * FROM film  
WHERE rating = 'PG-13';
```

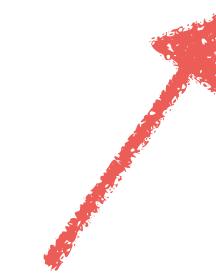


still a ***constant***, but may  
match more than one row

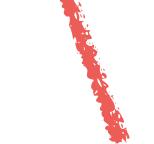
"ref"

```
SELECT * FROM film  
WHERE rating = 'PG-13';
```

KEY, but not  
necessarily unique



still a ***constant***, but may  
match more than one row

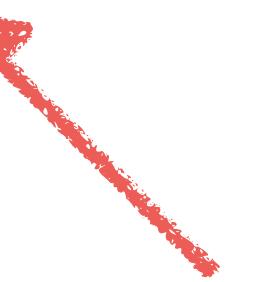


"ref\_or\_null"

```
SELECT * FROM film  
WHERE rating = 'PG-13'  
OR rating IS NULL;
```

"ref\_or\_null"

```
SELECT * FROM film  
WHERE rating = 'PG-13'  
OR rating IS NULL;
```



one pass to  
find 'PG-13'

"ref\_or\_null"

```
SELECT * FROM film  
WHERE rating = 'PG-13'  
OR rating IS NULL;
```



extra pass to find null values

one pass to  
find 'PG-13'

"eq\_ref"

```
SELECT film_id FROM film_actor
INNER JOIN film USING(film_id)
WHERE actor_id = 123;
```

"eq\_ref"

```
SELECT film_id FROM film actor
INNER JOIN film USING(film_id)
WHERE actor_id = 123;
```

type	possible_keys	key	key_len	ref
ref	idx_rating	idx_rating	2	const
<b>rows</b> Extra				
<b>223</b> Using index condition; Using filesort				

✓		✓		✓		✓	
+	-	-	-	-	-	-	-
type   possible_keys   key   key_len   ref							
+	-	-	-	-	-	-	-
ref   idx_rating   idx_rating   2   const							
+	-	-	-	-	-	-	-
							
+	-	-	-	-	-	-	-
rows   Extra							
+	-	-	-	-	-	-	-
223   Using index condition; Using filesort							
+	-	-	-	-	-	-	-

✓		✓		✓		✓	
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
type   possible_keys   key				key_len   ref			
+-----+-----+-----+-----+-----+-----+-----+-----+							
ref   idx_rating   idx_rating   2   const							
+-----+-----+-----+-----+-----+-----+-----+-----+							
rows	Extra						
+-----+-----+-----+-----+-----+-----+-----+-----+							
223	Using index condition; Using filesort						
+-----+-----+-----+-----+-----+-----+-----+-----+							

```
SELECT film_id FROM film_actor  
INNER JOIN film USING(film_id)  
WHERE actor_id = 123;
```

table	type	key	ref	rows
film_actor	ref	PRIMARY	const	32
film	eq_ref	PRIMARY	sakila.film_actor.film_id	1

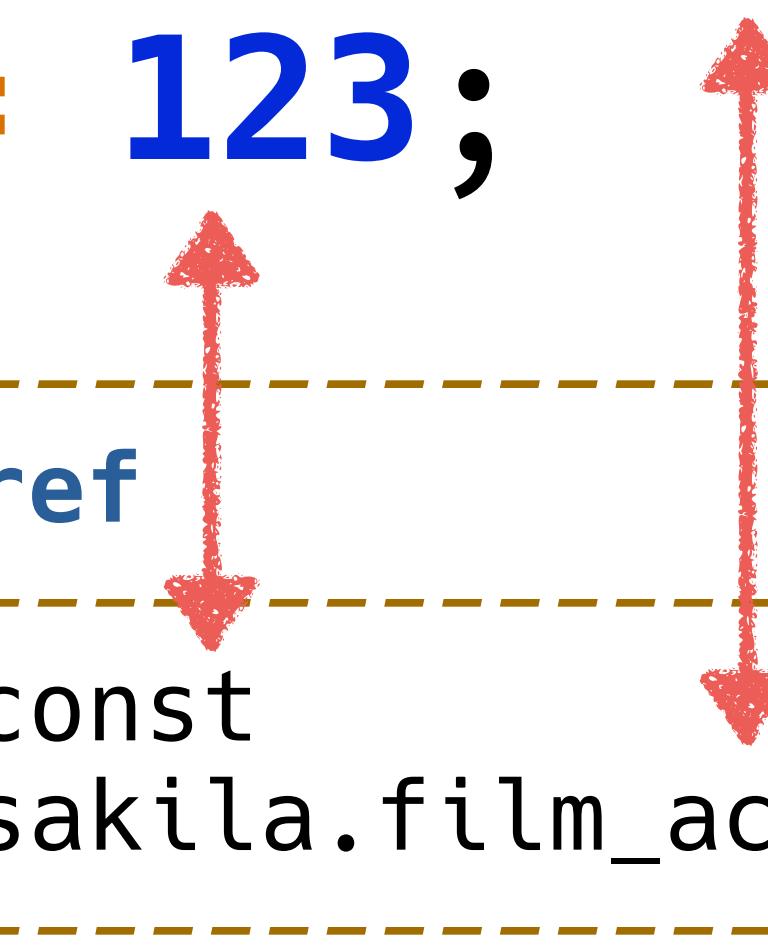
```
SELECT film_id FROM film_actor  
INNER JOIN film USING(film_id)  
WHERE actor_id = 123;
```

table	type	key	ref	rows
film_actor	ref	PRIMARY	const	32
film	eq_ref	PRIMARY	sakila.film_actor.film_id	1



```
SELECT film_id FROM film_actor  
INNER JOIN film USING(film_id)  
WHERE actor_id = 123;
```

table	type	key	ref	rows
film_actor	ref	PRIMARY	const	32
film	eq_ref	PRIMARY	sakila.film_actor.film_id	1

A diagram illustrating the execution flow of the query. Two red arrows point upwards from the WHERE clause 'actor\_id = 123' to the 'rows' column in the EXPLAIN output. One arrow points to the row for 'film\_actor' and the other to the row for 'film'. This visualizes how the optimizer translates the logical query into physical operations.

✓		✓		✓		✓	
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
type   possible_keys   key				key_len   ref			
+-----+-----+-----+-----+-----+-----+-----+-----+							
ref   idx_rating   idx_rating   2   const							
+-----+-----+-----+-----+-----+-----+-----+-----+							
rows	Extra						
+-----+-----+-----+-----+-----+-----+-----+-----+							
223	Using index condition; Using filesort						
+-----+-----+-----+-----+-----+-----+-----+-----+							

✓		✓		✓		✓		✓
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
type   possible_keys   key				key_len   ref				
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
ref   idx_rating   idx_rating   2   const								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
rows   Extra								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
223   Using index condition; Using filesort								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								

✓		✓		✓		✓		✓
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
type   possible_keys   key   key_len   ref								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
ref   idx_rating   idx_rating   2   const								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								

rows	Extra
223	Using index condition; Using filesort



```
SELECT COUNT(*) FROM film
WHERE rating = 'PG-13'
ORDER BY title;
```

COUNT(*)
223

✓		✓		✓		✓		✓
+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+
type   possible_keys   key   key_len   ref								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								
ref   idx_rating   idx_rating   2   const								
+-----+-----+-----+-----+-----+-----+-----+-----+-----+								

rows	Extra
223	Using index condition; Using filesort



✓						
+-----+-----+-----+-----+-----+-----+-----+						
type   possible_keys   key   key_len   ref						
+-----+-----+-----+-----+-----+-----+-----+						
ref   idx_rating   idx_rating   2   const						
+-----+-----+-----+-----+-----+-----+-----+						
✓						
+-----+-----+-----+-----+-----+-----+-----+						
rows   Extra						
+-----+-----+-----+-----+-----+-----+-----+						
223   Using index condition; Using filesort						
+-----+-----+-----+-----+-----+-----+-----+						

✓			✓			✓			✓		✓
+	-	-	-	-	-	-	-	-	-	-	-
type	possible_keys	key		key_len	ref						
+	-	-	-	-	-	-	-	-	-	-	-
ref	idx_rating	idx_rating	2	const							
+	-	-	-	-	-	-	-	-	-	-	-
✓											
+	-	-	-	-	-	-	-	-	-	-	-
rows	Extra										
+	-	-	-	-	-	-	-	-	-	-	-
223	Using index condition; Using filesort										
+	-	-	-	-	-	-	-	-	-	-	-



✓		✓		✓		✓		✓	
+	-	-	-	+	-	-	+	-	-
type   possible_keys   key   key_len   ref									

ref	idx_rating	idx_rating	2	const
+	-	-	-	-

✓									
+	-	-	-	-	-	-	-	-	-
rows   Extra									

223	Using index condition; Using filesort
+	-



rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

film_id	title	rating	<omitted for brevity>
435	HOTEL HAPPINESS	PG-13	etc...
565	MATRIX SNOWMAN	PG-13	etc...
940	VICTORY ACADEMY	PG-13	etc...

film_id	title	rating	<omitted for brevity>
435	MATRIX SNOWMAN	PG-13	etc...
565	HOTEL HAPPINESS	PG-13	etc...
940	VICTORY ACADEMY	PG-13	etc...

film_id	title	rating	<omitted for brevity>
435	VICTORY ACADEMY	PG-13	etc...
565	MATRIX SNOWMAN	PG-13	etc...
940	HOTEL HAPPINESS	PG-13	etc...

film_id	title	rating	<omitted for brevity>
435	MATRIX SNOWMAN	PG-13	etc...
565	VICTORY ACADEMY	PG-13	etc...
940	HOTEL HAPPINESS	PG-13	etc...

film_id	title	rating	<omitted for brevity>
435	MATRIX SNOWMAN	PG-13	etc...
565	VICTORY ACADEMY	PG-13	etc...
940	HOTEL HAPPINESS	PG-13	etc...

**SHOW INDEX FROM film WHERE Column\_name = 'title';**

Table	Non_unique	Key_name	Seq_in_index	Column_name	<omitted for brevity>
film	1	idx_title	1	title	etc...

```
CREATE INDEX idx_rating_title  
ON film(rating, title);
```

```
CREATE INDEX idx_rating_title  
ON film(rating, title);
```



```
CREATE INDEX idx_rating_title  
ON film(rating, title);
```



## idx\_rating\_title

rating	title	film_id
PG-13	HOTEL HAPPINESS	435
PG-13	MATRIX SNOWMAN	565
PG-13	VICTORY ACADEMY	940

# idx\_rating\_title

rating	title	film_id
PG-13	HOTEL HAPPINESS	435
PG-13	MATRIX SNOWMAN	565
PG-13	VICTORY ACADEMY	940

order is guaranteed!

+	-	-	-	-	-	-
type	possible_keys	key		key_len	ref	
+-----+-----+-----+-----+-----+-----+-----+						
ref	idx_rating, idx_rating_title	idx_rating_title	2		const	
+-----+-----+-----+-----+-----+-----+-----+						
+	-	-	-	-	-	-
rows	Extra					
+-----+-----+-----+-----+-----+-----+-----+						
223	Using index condition					
+-----+-----+-----+-----+-----+-----+-----+						

type	possible_keys	key	key_len	ref	
ref	idx_rating, idx_rating_title	idx_rating_title	2	const	

rows	Extra
223	Using index condition

type	possible_keys	key	key_len	ref	
ref	idx_rating, idx_rating_title	idx_rating_title	2	const	

rows	Extra
223	Using index condition

type	possible_keys	key	key_len	ref	
ref	idx_rating, idx_rating_title	idx_rating_title	2	const	

rows	Extra
223	Using index condition

type	possible_keys	key	key_len	ref	
ref	idx_rating, idx_rating_title	idx_rating_title	2	const	

rows	Extra
223	Using index condition

**<strong>**

These films are rated PG-13!

**</strong>**

[HOTEL HAPPINESS](/film/435)

[MATRIX SNOWMAN](/film/565)

[VICTORY ACADEMY](/film/940)

**<strong>**

These films are rated PG-13!

**</strong>**

**<a href="/film/435">HOTEL HAPPINESS</a>**

**<a href="/film/565">MATRIX SNOWMAN</a>**

**<a href="/film/940">VICTORY ACADEMY</a>**



film\_id, title

```
SELECT * FROM film  
WHERE rating = 'PG-13'  
ORDER BY title;
```

```
SELECT X FROM film  
WHERE rating = 'PG-13'  
ORDER BY title;
```

```
SELECT film_id, title  
FROM film  
WHERE rating = 'PG-13'  
ORDER BY title;
```

```
SELECT film_id, title  
FROM film  
WHERE rating = 'PG-13'  
ORDER BY title;
```

+	-	-	-	-	-	-
	type	possible_keys	key		key_len	ref
+	-	-	-	-	-	-
	ref	idx_rating, idx_rating_title	idx_rating_title	2		const
+	-	-	-	-	-	-
+	-	-	-	-	-	-
	rows	Extra				
+	-	-	-	-	-	-
	223	Using where; Using index				
+	-	-	-	-	-	-

+	-	-	-	-	-	-
type	possible_keys	key		key_len	ref	
+-----+-----+-----+-----+-----+-----+-----+						
ref	idx_rating, idx_rating_title	idx_rating_title	2		const	
+-----+-----+-----+-----+-----+-----+-----+						
+	-	-	-	-	-	-
rows	Extra					
+-----+-----+-----+-----+-----+-----+-----+						
223	Using where;	Using index				
+-----+-----+-----+-----+-----+-----+-----+						

type	possible_keys	key	key_len	ref
ref	idx_rating, idx_rating_title	idx_rating_title	2	const

rows	Extra
223	Using where; Using index

type	possible_keys	key	key_len	ref
ref	idx_rating, idx_rating_title	idx_rating_title	2	const

rows	Extra
223	Using where; Using index

```
SHOW TABLE STATUS  
WHERE Name = 'film' \G
```

Name: film  
Engine: InnoDB  
**Version:** 10  
Row\_format: Dynamic  
**Rows:** 1000  
Avg\_row\_length: 196  
Data\_length: 196608  
Max\_data\_length: 0  
Index\_length: 81920  
Data\_free: 0  
Auto\_increment: 1001  
Create\_time: 2017-01-28 13:06:42  
Update\_time: 2017-01-28 12:35:48  
Check\_time: NULL  
**Collation:** utf8\_general\_ci  
Checksum: NULL  
Create\_options:  
**Comment:**

Name: film  
Engine: InnoDB  
Version: 10  
Row\_format: Dynamic  
Rows: 1000  
Avg\_row\_length: 196  
**Data\_length:** 196608  
Max\_data\_length: 0  
**Index\_length:** 81920  
Data\_free: 0  
Auto\_increment: 1001  
Create\_time: 2017-01-28 13:06:42  
Update\_time: 2017-01-28 12:35:48  
Check\_time: NULL  
Collation: utf8\_general\_ci  
Checksum: NULL  
Create\_options:  
Comment:

Data\_length: **196608**

Index\_length: **81920**

**ANALYZE TABLE film;**

Table	Op	Msg_type	Msg_text
sakila.film	analyze	status	0K

Data\_length: **196608**

Index\_length: **147456**

$$\begin{array}{r} \mathbf{147456} \\ - \mathbf{81920} \\ \hline \mathbf{65536} \end{array}$$

(with `idx_rating + idx_rating_title`)  
(original index length)

# **INDEXES ARE NOT "FREE" !**

```
DROP INDEX idx_rating  
ON film;
```

**ANALYZE TABLE film;**

**SHOW TABLE STATUS  
WHERE Name = 'film' \G**

Data\_length: **196608**

Index\_length: **131072**

$$\begin{array}{r} \textcolor{blue}{147456} \\ - \textcolor{blue}{131072} \\ \hline \textcolor{blue}{16384} \end{array}$$

(with `idx_rating + idx_rating_title`)  
(after removing `idx_rating`)

$$\begin{array}{r} 16384 \\ \div 196608 \\ \hline \approx 8.3\% \end{array}$$

$$\begin{array}{r} 1 \text{ TB} \\ \times 8.3\% \\ \hline \sim 80 \text{ GB} \end{array}$$

rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

rating	title	film_id
G	MINORITY KISS	581
G	SATURDAY LAMBS	764
G	TIMBERLAND SKY	891
PG	CHARADE DUFFEL	137
PG	CHASING FIGHT	139
PG	FERRIS MOTHER	308
PG-13	HOTEL HAPPINESS	435
PG-13	MATRIX SNOWMAN	565
PG-13	VICTORY ACADEMY	940
R	CHARIOTS CONSPIRACY	138
R	CLUELESS BUCKET	162
R	MAUDE MOD	566
NC-17	CHOCOLAT HARRY	147
NC-17	CRYSTAL BREAKING	198
NC-17	VAMPIRE WHALE	933

rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

rating	title	film_id
G	MINORITY KISS	581
G	SATURDAY LAMBS	764
G	TIMBERLAND SKY	891
PG	CHARADE DUFFEL	137
PG	CHASING FIGHT	139
PG	FERRIS MOTHER	308
PG-13	HOTEL HAPPINESS	435
PG-13	MATRIX SNOWMAN	565
PG-13	VICTORY ACADEMY	940
R	CHARIOTS CONSPIRACY	138
R	CLUELESS BUCKET	162
R	MAUDE MOD	566
NC-17	CHOCOLAT HARRY	147
NC-17	CRYSTAL BREAKING	198
NC-17	VAMPIRE WHALE	933

rating	film_id
G	581
G	764
G	891
PG	137
PG	139
PG	308
PG-13	435
PG-13	565
PG-13	940
R	138
R	162
R	566
NC-17	147
NC-17	198
NC-17	933

rating	title	film_id
G	MINORITY KISS	581
G	SATURDAY LAMBS	764
G	TIMBERLAND SKY	891
PG	CHARADE DUFFEL	137
PG	CHASING FIGHT	139
PG	FERRIS MOTHER	308
PG-13	HOTEL HAPPINESS	435
PG-13	MATRIX SNOWMAN	565
PG-13	VICTORY ACADEMY	940
R	CHARIOTS CONSPIRACY	138
R	CLUELESS BUCKET	162
R	MAUDE MOD	566
NC-17	CHOCOLAT HARRY	147
NC-17	CRYSTAL BREAKING	198
NC-17	VAMPIRE WHALE	933

+-----+-----+-----+-----+-----+-----+-----+	id   select_type   table   partitions   type   possible_keys   key	+-----+-----+-----+-----+-----+-----+-----+
	1   SIMPLE   film   NULL   ref   idx_rating_title   idx_rating_title	

+-----+-----+-----+-----+-----+	key_len   ref   rows   filtered   Extra	+-----+-----+-----+-----+-----+
	2   const   223   100.00   Using where; Using index	

+-----+ <th>id</th> <th>select_type</th> <th>table</th> <th>partitions</th> <th>type</th> <th>possible_keys</th> <th>key</th> <th>+-----+</th>	id	select_type	table	partitions	type	possible_keys	key	+-----+
1   SIMPLE   film   NULL   ref   idx_rating_title   idx_rating_title	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+	+-----+

+-----+ <th>key_len</th> <th>ref</th> <th>rows</th> <th>extra</th> <th>+-----+</th>	key_len	ref	rows	extra	+-----+
2   const   223   10.00   Using where; Using index	+-----+	+-----+	+-----+	+-----+	+-----+

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
```

```
SELECT rating, film_id  
FROM film AS outer_film  
WHERE rating = 'PG-13' AND film_id NOT IN (  
    → SELECT film_id FROM film AS inner_film  
    INNER JOIN inventory USING (film_id)  
    INNER JOIN rental USING (inventory_id)  
);
```

```
SELECT rating, film_id  
FROM film AS outer_film  
WHERE rating = 'PG-13' AND film_id NOT IN (  
    → SELECT film_id FROM film AS inner_film  
    INNER JOIN inventory USING (film_id)  
    INNER JOIN rental USING (inventory_id)  
);
```

rating	film_id
PG-13	33
PG-13	36
PG-13	108
PG-13	325
PG-13	642
PG-13	701
PG-13	712
PG-13	801
PG-13	909
PG-13	943

<code>id</code>	<code>select_type</code>	<code>table</code>	<code>partitions</code>	<code>type</code>	<code>possible_keys</code>
1	<b>PRIMARY</b>	film	NULL	ref	<code>idx_rating_title</code>
2	DEPENDENT SUBQUERY	film	NULL	eq_ref	<b>PRIMARY</b>
2	DEPENDENT SUBQUERY	inventory	NULL	ref	<b>PRIMARY</b> , <code>idx_fk_film_id</code>
2	DEPENDENT SUBQUERY	rental	NULL	ref	<code>idx_fk_inventory_id</code>

<code>key</code>	<code>key_len</code>	<code>ref</code>	<code>rows</code>	<code>filtered</code>	<code>Extra</code>
<code>idx_rating_title</code>	2	const	223	100.00	<code>Using where; Using index</code>
<b>PRIMARY</b>	2	func	1	100.00	<code>Using index</code>
<code>idx_fk_film_id</code>	2	func	4	100.00	<code>Using where; Using index</code>
<code>idx_fk_inventory_id</code>	3	sakila.inventory.inventory_id	1	100.00	<code>Using index</code>

<code>id</code>	<code>select_type</code>	<code>table</code>	<code>partitions</code>	<code>type</code>	<code>possible_keys</code>
1	<b>PRIMARY</b>	film	NULL	<b>ref</b>	<code>idx_rating_title</code>
2	DEPENDENT SUBQUERY	film	NULL	<b>eq_ref</b>	<b>PRIMARY</b>
2	DEPENDENT SUBQUERY	inventory	NULL	<b>ref</b>	<b>PRIMARY</b> , <code>idx_fk_film_id</code>
2	DEPENDENT SUBQUERY	rental	NULL	<b>ref</b>	<code>idx_fk_inventory_id</code>

<code>key</code>	<code>key_len</code>	<code>ref</code>	<code>rows</code>	<code>filtered</code>	<code>Extra</code>
<code>idx_rating_title</code>	2	const	223	100.00	<code>Using where; Using index</code>
<b>PRIMARY</b>	2	func	1	100.00	<code>Using index</code>
<code>idx_fk_film_id</code>	2	func	4	100.00	<code>Using where; Using index</code>
<code>idx_fk_inventory_id</code>	3	sakila.inventory.inventory_id	1	100.00	<code>Using index</code>

```
SELECT rating, film_id  
FROM film AS outer_film  
WHERE rating = 'PG-13' AND film_id NOT IN (  
    SELECT film_id FROM film AS inner_film  
    INNER JOIN inventory USING (film_id)  
    INNER JOIN rental USING (inventory_id)  
);
```

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
```

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
16044 rows in set (0.02 sec)
);
```

```
EXPLAIN SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
```

```
EXPLAIN SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
4 rows in set, 1 warning (0.01 sec)
```

```
EXPLAIN SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
4 rows in set, 1 warning (0.01 sec)
```

**SHOW WARNINGS \G**

\*\*\*\*\* 1. row \*\*\*\*\*

**Level:** Note

**Code:** 1003

Message: /\* select#1 \*/ select `sakila`.`outer\_film`.`rating`  
AS `rating`, `sakila`.`outer\_film`.`film\_id` AS `film\_id` from  
`sakila`.`film` `outer\_film` where  
(`sakila`.`outer\_film`.`rating` = 'PG-13') and  
(not<in\_optimizer>(`sakila`.`outer\_film`.`film\_id`,<exists>(  
/\* select#2 \*/ select 1 from `sakila`.`film` `inner\_film` join  
`sakila`.`inventory` join `sakila`.`rental` where  
(`sakila`.`inventory`.`film\_id` =  
`sakila`.`inner\_film`.`film\_id`) and  
(`sakila`.`rental`.`inventory\_id` =  
`sakila`.`inventory`.`inventory\_id`) and  
(<cache>(`sakila`.`outer\_film`.`film\_id`) =  
`sakila`.`inner\_film`.`film\_id`))))))  
**1 row in set (0.00 sec)**

\*\*\*\*\* 1. row \*\*\*\*\*

Level: Note

Code: 1003

Message: /\* select#1 \*/ select `sakila`.`outer\_film`.`rating`  
AS `rating`, `sakila`.`outer\_film`.`film\_id` AS `film\_id` from  
`sakila`.`film` `outer\_film` where  
(`sakila`.`outer\_film`.`rating` = 'PG-13') and  
(not<in\_optimizer>(`sakila`.`outer\_film`.`film\_id`,<exists>(  
/\* select#2 \*/ select 1 from `sakila`.`film` `inner\_film` join  
`sakila`.`inventory` join `sakila`.`rental` where  
(`sakila`.`inventory`.`film\_id` =  
`sakila`.`inner\_film`.`film\_id`) and  
(`sakila`.`rental`.`inventory\_id` =  
`sakila`.`inventory`.`inventory\_id`) and  
(<cache>(`sakila`.`outer\_film`.`film\_id`) =  
`sakila`.`inner\_film`.`film\_id`))))))  
1 row in set (0.00 sec)

\*\*\*\*\* 1. row \*\*\*\*\*

Level: Note

Code: **1003**

Message: /\* select#1 \*/ select `sakila`.`outer\_film`.`rating`  
AS `rating`, `sakila`.`outer\_film`.`film\_id` AS `film\_id` from  
`sakila`.`film` `outer\_film` where  
(`sakila`.`outer\_film`.`rating` = 'PG-13') and  
(not(<in\_optimizer>(`sakila`.`outer\_film`.`film\_id`),<exists>(  
/\* select#2 \*/ select 1 from `sakila`.`film` `inner\_film` join  
`sakila`.`inventory` join `sakila`.`rental` where  
(`sakila`.`inventory`.`film\_id` =  
`sakila`.`inner\_film`.`film\_id`) and  
(`sakila`.`rental`.`inventory\_id` =  
`sakila`.`inventory`.`inventory\_id`) and  
(<cache>(`sakila`.`outer\_film`.`film\_id`)) =  
`sakila`.`inner\_film`.`film\_id`))))))  
**1 row in set (0.00 sec)**

\*\*\*\*\* 1. row \*\*\*\*\*

Level: Note

Code: **1003**

Message: /\* select#1 \*/ select `sakila`.`outer\_film`.`rating`  
AS `rating`, `sakila`.`outer\_film`.`film\_id` AS `film\_id` FROM  
`sakila`.`film` `outer\_film` WHERE  
(`sakila`.`outer\_film`.`rating` = 'PG-13') AND  
(NOT(<in\_optimizer>(`sakila`.`outer\_film`.`film\_id`),<exists>(  
/\* select#2 \*/ select 1 FROM `sakila`.`film` `inner\_film` JOIN  
`sakila`.`inventory` JOIN `sakila`.`rental` WHERE  
(`sakila`.`inventory`.`film\_id` =  
`sakila`.`inner\_film`.`film\_id`) AND  
(`sakila`.`rental`.`inventory\_id` =  
`sakila`.`inventory`.`inventory\_id`) AND  
(<cache>(`sakila`.`outer\_film`.`film\_id`) =  
`sakila`.`inner\_film`.`film\_id`))))))  
**1 row in set (0.00 sec)**

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND
    NOT EXISTS (
        SELECT 1 FROM film
        JOIN inventory
        JOIN rental
        WHERE inventory.film_id = film.film_id
            AND rental.inventory_id = inventory.inventory_id
            AND outer_film.film_id = film.film_id
    )
```

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND
    NOT EXISTS (
        SELECT 1 FROM film
        JOIN inventory
        JOIN rental
        WHERE inventory.film_id = film.film_id
        AND rental.inventory_id = inventory.inventory_id
        AND outer_film.film_id = film.film_id
    )
```

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND
    NOT EXISTS (
        SELECT 1 FROM film
        JOIN inventory
        JOIN rental
        WHERE inventory.film_id = film.film_id
            AND rental.inventory_id = inventory.inventory_id
            AND outer_film.film_id = film.film_id
    )
ERROR 1054 (42S22): Unknown column 'outer_film.film_id'
in 'where clause'
```

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND
    NOT EXISTS (
        SELECT 1 FROM film
        JOIN inventory
        JOIN rental
        WHERE inventory.film_id = film.film_id
            AND rental.inventory_id = inventory.inventory_id
            AND outer_film.film_id = film.film_id
    )
ERROR 1054 (42S22): Unknown column 'outer_film.film_id'
in 'where clause'
```

"for each of these..."

... do this!

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND
NOT EXISTS (
    SELECT 1 FROM film
    JOIN inventory
    JOIN rental
    WHERE inventory.film_id = film.film_id
        AND rental.inventory_id = inventory.inventory_id
        AND outer_film.film_id = film.film_id
)
```

```
SELECT rating, film.film_id FROM film
LEFT JOIN (
    SELECT film_id FROM inventory
    INNER JOIN rental USING (inventory_id)
) rented_films ON film.film_id = rented_films.film_id
WHERE rented_films.film_id IS NULL
AND rating = 'PG-13';
```

rating	film_id
PG-13	33
PG-13	36
PG-13	108
PG-13	325
PG-13	642
PG-13	701
PG-13	712
PG-13	801
PG-13	909
PG-13	943

<b>id</b>	<b>select_type</b>	<b>table</b>	<b>partitions</b>	<b>type</b>	<b>possible_keys</b>	<b>key</b>
1	SIMPLE	film	NULL	ref	idx_rating_title	idx_rating_title
1	SIMPLE	inventory	NULL	ref	PRIMARY, idx_fk_film_id	idx_fk_film_id
1	SIMPLE	rental	NULL	ref	idx_fk_inventory_id	idx_fk_inventory_id

<b>key_len</b>	<b>ref</b>	<b>rows</b>	<b>filtered</b>	<b>Extra</b>
2	const	223	100.00	Using index
2	sakila.film.film_id	4	100.00	Using where; Using index
3	sakila.inventory.inventory_id	3	100.00	Using index

id	select_type	table	partitions	type	possible_keys	key
1	SIMPLE	film	NULL	ref	idx_rating_title	idx_rating_title
1	SIMPLE	inventory	NULL	ref	PRIMARY, idx_fk_film_id	idx_fk_film_id
1	SIMPLE	rental	NULL	ref	idx_fk_inventory_id	idx_fk_inventory_id

key_len	ref	rows	filtered	Extra
2	const	223	100.00	Using index
2	sakila.film.film_id	4	100.00	Using where; Using index
3	sakila.inventory.inventory_id	3	100.00	Using index

Tables_in_performance_schema		
accounts	events_waits_history	replication_connection_configuration
cond_instances	events_waits_history_long	replication_connection_status
events_stages_current	events_waits_summary_by_account_by_event_name	replication_group_member_stats
events_stages_history	events_waits_summary_by_host_by_event_name	replication_group_members
events_stages_history_long	events_waits_summary_by_instance	rwlock_instances
events_stages_summary_by_account_by_event_name	events_waits_summary_by_thread_by_event_name	session_account_connect_attrs
events_stages_summary_by_host_by_event_name	events_waits_summary_by_user_by_event_name	session_connect_attrs
events_stages_summary_by_thread_by_event_name	events_waits_summary_global_by_event_name	session_status
events_stages_summary_by_user_by_event_name	file_instances	session_variables
events_stages_summary_global_by_event_name	file_summary_by_event_name	setup_actors
events_statements_current	file_summary_by_instance	setup_consumers
events_statements_history	global_status	setup_instruments
events_statements_history_long	global_variables	setup_objects
events_statements_summary_by_account_by_event_name	host_cache	setup_timers
events_statements_summary_by_digest	hosts	socket_instances
events_statements_summary_by_host_by_event_name	memory_summary_by_account_by_event_name	socket_summary_by_event_name
events_statements_summary_by_program	memory_summary_by_host_by_event_name	socket_summary_by_instance
events_statements_summary_by_thread_by_event_name	memory_summary_by_thread_by_event_name	status_by_account
events_statements_summary_by_user_by_event_name	memory_summary_by_user_by_event_name	status_by_host
events_statements_summary_global_by_event_name	memory_summary_global_by_event_name	status_by_thread
events_transactions_current	metadata_locks	status_by_user
events_transactions_history	mutex_instances	table_handles
events_transactions_history_long	objects_summary_global_by_type	table_io_waits_summary_by_index_usage
events_transactions_summary_by_account_by_event_name	performance_timers	table_io_waits_summary_by_table
events_transactions_summary_by_host_by_event_name	prepared_statements_instances	table_lock_waits_summary_by_table
events_transactions_summary_by_thread_by_event_name	replication_applier_configuration	threads
events_transactions_summary_by_user_by_event_name	replication_applier_status	user_variables_by_thread
events_transactions_summary_global_by_event_name	replication_applier_status_by_coordinator	users
events_waits_current	replication_applier_status_by_worker	variables_by_thread

<https://dev.mysql.com/doc/refman/5.7/en/performance-schema.html>

# "The Short Version"

1. Turn it on
2. Run the query
3. Get the event\_id
4. Look at stuff!

[https://dev.mysql.com/doc/refman/5.7/en/  
performance-schema-query-profiling.html](https://dev.mysql.com/doc/refman/5.7/en/performance-schema-query-profiling.html)

```
SELECT rating, film.film_id FROM film
LEFT JOIN (
    SELECT film_id FROM inventory
    INNER JOIN rental USING (inventory_id)
) rented_films ON film.film_id = rented_films.film_id
WHERE rented_films.film_id IS NULL
AND rating = 'PG-13';
```

Stage	Duration
stage/sql/starting	0.000116
stage/sql/checking permissions	0.000004
stage/sql/checking permissions	0.000002
stage/sql/checking permissions	0.000006
stage/sql/Opening tables	0.000049
stage/sql/init	0.000066
stage/sql/ <b>System lock</b>	0.000011
stage/sql/optimizing	0.000018
stage/sql/ <b>statistics</b>	0.000117
stage/sql/preparing	0.000023
stage/sql/executing	0.000002
stage/sql/Sending data	0.001784
stage/sql/end	0.000003
stage/sql/query end	0.000008
stage/sql/closing tables	0.000010
stage/sql/freeing items	0.000026
stage/sql/cleaning up	NULL

17 rows in set (0.00 sec)

```
SELECT rating, film_id
FROM film AS outer_film
WHERE rating = 'PG-13' AND film_id NOT IN (
    SELECT film_id FROM film AS inner_film
    INNER JOIN inventory USING (film_id)
    INNER JOIN rental USING (inventory_id)
);
```

Stage	Duration
stage/sql/starting	0.000112
stage/sql/checking permissions	0.000011
stage/sql/checking permissions	0.000002
stage/sql/checking permissions	0.000002
stage/sql/checking permissions	0.000005
stage/sql/Opening tables	0.000029
stage/sql/init	0.000070
stage/sql/ <b>System lock</b>	0.000011
stage/sql/optimizing	0.000013
stage/sql/ <b>statistics</b>	0.000077
stage/sql/preparing	0.000017
stage/sql/optimizing	0.000011
stage/sql/ <b>statistics</b>	0.000052
stage/sql/preparing	0.000012
stage/sql/executing	0.000003
stage/sql/Sending <b>data</b>	0.000031
stage/sql/executing	0.000002
stage/sql/Sending <b>data</b>	0.000038
stage/sql/executing	0.000002

stage/sql/Sending data	0.000014
stage/sql/executing	0.000001
stage/sql/Sending data	0.000016
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000013
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000001
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000018
stage/sql/end	0.000003
stage/sql/query end	0.000007
stage/sql/closing tables	0.000008
stage/sql/freeing items	0.000021
stage/sql/cleaning up	0.000001

+-----+  
467 rows in set (0.00 sec)

stage/sql/Sending data	0.000014
stage/sql/executing	0.000001
stage/sql/Sending data	0.000016
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000013
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000014
stage/sql/executing	0.000001
stage/sql/Sending data	0.000014
stage/sql/executing	0.000002
stage/sql/Sending data	0.000018
stage/sql/end	0.000003
stage/sql/query end	0.000007
stage/sql/closing tables	0.000008
stage/sql/freeing items	0.000021
stage/sql/cleaning up	0.000001

!!! → 467 rows in set (0.00 sec)

# "DEPENDENT SUBQUERY IS BAD!"

~~"DEPENDENT SUBQUERY IS BAD!"~~

~~"DEPENDENT SUBQUERY IS BAD!"~~

DEPENDENT SUBQUERY IS  
SOMETHING TO INVESTIGATE

~~"DEPENDENT SUBQUERY IS BAD!"~~

DEPENDENT SUBQUERY IS  
SOMETHING TO INVESTIGATE  
AND SO ARE...

- DEPENDENT UNION
- UNCACHEABLE SUBQUERY
- UNCACHEABLE UNION

# TAKEAWAYS

# EXPLAIN

# PROFILE

# TEST

# "CHEAT"

<https://joind.in/talk/129ae>

(in case you missed it...)





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