

# Напредни бази на податоци

## Фаза 4- Индекси и оптимизација на прашалници

### Проект: Cooksy

Илина Стеваноска 231118

Христина Босилковска 231187

Магдалена Станковска 231209

#### View 1: all\_recipes

1. Овој поглед се користи за прикажување на сите рецепти во системот, најчесто без филтри или со pagination. Бидејќи не користи JOIN или WHERE услови, не се применуваат индекси.
2. Заклучок: Прифатливо време, не е потребна оптимизација.

#### View 2: recipe\_details

1. Случај на употреба: Овој поглед се користи кога корисникот сака да ги види целосните информации за еден рецепт. Перформансите се клучни бидејќи ова е најчесто посетуваната страна.
2. Примарен филтер за овој поглед е recipe\_id додека исто така може да се пребарува и по кујна cuisine\_id.

Иницијално извршување на погледот.

```
explain analyse select * from public.recipe_details where id = 45846;
```

```
ts 1 x
in analyse select * from public.recipe_details | Enter a SQL expression to filter results (use Ctrl+Space)
QUERY PLAN
Hash Right Join (cost=8.45..12.86 rows=1 width=801) (actual time=0.247..0.309 rows=1 loops=1)
 Hash Cond: (c.id = r.cuisine_id)
  -> Seq Scan on cuisine c (cost=0.00..3.90 rows=190 width=13) (actual time=0.040..0.084 rows=190 loops=1)
  -> Hash (cost=8.44..8.44 rows=1 width=792) (actual time=0.145..0.146 rows=1 loops=1)
       Buckets: 1024 Batches: 1 Memory Usage: 9kB
       -> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=792) (actual time=0.132..0.133 rows=1 loops=1)
           Index Cond: (id = 45846)
Planning Time: 11.428 ms
Execution Time: 0.413 ms
```

3. ave Cancel Script 200 9 Rows: 1 9 row(s) fetched - 50ms

```
explain analyse select * from public.recipe_details where cuisine_id = 43;
```

QUERY PLAN

Nested Loop Left Join (cost=0.00..14915.13 rows=17219 width=801) (actual time=0.298..172.992 rows=16912 loops=1)

- > Seq Scan on recipe r (cost=0.00..14695.51 rows=17219 width=792) (actual time=0.270..168.193 rows=16912 loops=1)
  - Filter: (cuisine\_id = 43)
  - Rows Removed by Filter: 214729
- > Materialize (cost=0.00..4.38 rows=1 width=13) (actual time=0.000..0.000 rows=1 loops=16912)
  - > Seq Scan on cuisine c (cost=0.00..4.38 rows=1 width=13) (actual time=0.020..0.021 rows=1 loops=1)
    - Filter: (id = 43)
    - Rows Removed by Filter: 42

Planning Time: 0.258 ms  
Execution Time: 173.699 ms

ave Cancel Script [Icons] 200 10 Rows: 1 10 row(s) fetched - 279ms

4.

Времето изминато во извршување на операциите insert и update изнесува.

```
INSERT INTO recipe ( name, description, servings, proteins, fat, carbs,
  spice_level, total_time, calories, cuisine_id
) VALUES ('Test Recipe', 'Recipe used for performance testing', 2, 20, 10, 30, 3, 25, 450, 1);
```

Rows: 1 1 row(s) updated - 351ms, on 2026-05-14 at 17:14:45

```
update recipe set calories = 500 where cuisine_id = 1;
```

5.

6. Оптимизација: Со цел да се забрза спојувањето на табелите и филтрирањето по тип на кујна, се додава индекс на cuisine\_id

```
CREATE INDEX IF NOT EXISTS idx_recipe_cuisine_id ON recipe(cuisine_id);
```

```
explain analyse select * from public.recipe_details where id = 45846;
```

QUERY PLAN

Hash Right Join (cost=8.45..12.86 rows=1 width=801) (actual time=0.078..0.107 rows=1 loops=1)

- Hash Cond: (c.id = r.cuisine\_id)
  - > Seq Scan on cuisine c (cost=0.00..3.90 rows=190 width=13) (actual time=0.019..0.033 rows=190 loops=1)
  - > Hash (cost=8.44..8.44 rows=1 width=792) (actual time=0.041..0.042 rows=1 loops=1)
    - Buckets: 1024 Batches: 1 Memory Usage: 9kB
    - > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=792) (actual time=0.035..0.036 rows=1)
      - Index Cond: (id = 45846)

Planning Time: 0.265 ms  
Execution Time: 0.150 ms

ave Cancel Script [Icons] 200 9 Rows: 1 9 row(s) fetched - 116ms

7.

```
explain analyse select * from public.recipe_details where cuisine_id = 43;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop Left Join (cost=193.74..13017.43 rows=17219 width=801) (actual time=2.208..19.294 rows=16912 loops=1)

-> Bitmap Heap Scan on recipe r (cost=193.74..12797.81 rows=17219 width=792) (actual time=2.158..11.944 rows=16912 loops=1)

Recheck Cond: (cuisine\_id = 43)

Heap Blocks: exact=4254

-> Bitmap Index Scan on idx\_recipe\_cuisine\_id (cost=0.00..189.44 rows=17219 width=0) (actual time=1.372..1.373 rows=16912 loops=1)

Index Cond: (cuisine\_id = 43)

-> Materialize (cost=0.00..4.38 rows=1 width=13) (actual time=0.000..0.000 rows=1 loops=16912)

-> Seq Scan on cuisine c (cost=0.00..4.38 rows=1 width=13) (actual time=0.043..0.043 rows=1 loops=1)

Filter: (id = 43)

Rows Removed by Filter: 42

Planning Time: 0.673 ms

Execution Time: 19.969 ms

8. Save Cancel Script [Icons] 200 12 Rows: 1 12 row(s) fetched - 95ms

- Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```
INSERT INTO recipe ( name, description, servings, proteins, fat, carbs,
    spice_level, total_time, calories, cuisine_id
) VALUES ('Test Recipe2', 'Recipe used for performance testing', 2, 20, 10, 30, 3, 25, 450, 1);
```

Rows: 1 1 row(s) updated - 136ms, on 2026-05-14 at 17:43:41

```
update recipe set calories = 400 where cuisine_id = 1;
```

Rows: 1 2 row(s) updated - 302ms, on 2026-05-14 at 17:45:38

### View 3: quick\_recipes

- Примарен филтер за овој поглед е total\_time.
- Случај на употреба: Корисниците често пребаруваат "брзи рецепти" кои се готови за под 30 минути.
- Проблем: full scan на табелата recipe.
- Иницијално извршување на погледот.

```
explain analyse select * from public.quick_recipes where total_time < 15 order by total_time;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Sort (cost=17699.43..17780.35 rows=32369 width=40) (actual time=76.340..78.826 rows=31709 loops=1)

Sort Key: recipe.total\_time

Sort Method: quicksort Memory: 2570kB

-> Seq Scan on recipe (cost=0.00..15274.61 rows=32369 width=40) (actual time=0.025..68.675 rows=31709 loops=1)

Filter: ((total\_time <= 30) AND (total\_time < 15))

Rows Removed by Filter: 199932

Planning Time: 0.166 ms

Execution Time: 79.889 ms

Save Cancel Script

```
explain analyse select * from public.quick_recipes where id = 48080;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Index Scan using recipe\_pkey on recipe (cost=0.42..8.44 rows=1 width=40) (actual time=0.046..0.048 rows=1 loops=1)

Index Cond: (id = 48080)

Filter: (total\_time <= 30)

Planning Time: 0.318 ms

Execution Time: 0.072 ms

Save Cancel Script

- Времето изминато во извршување на операциите insert и update изнесува.

```
INSERT INTO recipe ( name, total_time, calories) VALUES ( 'Quick Pasta', 15, 350);
```

Rows: 1 1 row(s) updated - 242ms, on 2026-05-14 at 17:56:50

- update recipe set calories = 500 where total\_time = 25;

```
13206 row(s) updated - 1.188s, on 2026-05-14 at 18:06:36
```

- Оптимизација: За да може базата брзо да ги подреди и филтрира рецептите според времето на подготовка, се додава индекс на колоната total\_time.

```
CREATE INDEX IF NOT EXISTS idx_recipe_total_time ON recipe(total_time);
```

```
select * from public.quick_recipes where id = 48080;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Index Scan using recipe\_pkey on recipe (cost=0.42..8.44 rows=1 width=40) (actual time=0.020..0.022 rows=1 loops=1)

Index Cond: (id = 48080)

Filter: (total\_time <= 30)

Planning Time: 0.197 ms

Execution Time: 0.047 ms

Save Cancel Script

200 5 Rows: 1 5 row(s) fetched - 46ms

8.

```
explain analyse select * from public.quick_recipes where total_time < 15 order by total_time;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Sort (cost=15177.43..15258.43 rows=32397 width=40) (actual time=39.048..41.045 rows=31709 loops=1)

Sort Key: recipe.total\_time

Sort Method: quicksort Memory: 2570kB

-> Bitmap Heap Scan on recipe (cost=464.36..12750.32 rows=32397 width=40) (actual time=3.968..29.475 rows=31709 loops=1)

Recheck Cond: ((total\_time <= 30) AND (total\_time < 15))

Heap Blocks: exact=8632

-> Bitmap Index Scan on idx\_recipe\_total\_time (cost=0.00..456.27 rows=32397 width=0) (actual time=2.298..2.298 rows=32397 loops=1)

Index Cond: ((total\_time <= 30) AND (total\_time < 15))

Planning Time: 0.205 ms

Execution Time: 42.272 ms

Save Cancel Script

200 10 Rows: 1 10 row(s) fetched - 94ms

9.

10. Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```
INSERT INTO recipe ( name, total_time, calories) VALUES ( 'Quick Pasta 2', 15, 350);
```

1 row(s) updated - 148ms, on 2026-05-14 at 18:36:47

```
UPDATE recipe SET calories = 500 WHERE total_time = 25;
```

Execution plan - 2 ×

Node Type	Entity	Cost	Rows	Time	Condition
ModifyTable	recipe	153.36 - 126...	0	349.845	
Bitmap Heap Scan	recipe	153.36 - 126...	13206	20.489	
Bitmap Index Scan	idx_recipe_total_ti...	0.00 - 150.10	23262	1.915	(total_time = 25)

13206 row(s) updated - 2.989s, on 2026-05-14 at 18:39:13

## View 4: recipe\_ingredients\_view

1. Секогаш кога некој ќе отвори рецепт, базата мора да ги повлече сите негови состојки. Ова повлекува „JOIN“ меѓу три табели (рецепти, состојки и нивната врска).
2. Иницијално извршување на погледот.

```
explain analyze select * from public.recipe_ingredients_view where recipe_id=45897
```

```
QUERY PLAN
Nested Loop (cost=1.14.144.50 rows=11 width=273) (actual time=0.047..0.082 rows=8 loops=1)
-> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.022..0.023 rows=1 loops=1)
    Index Cond: (id = 45897)
-> Nested Loop (cost=0.72..135.95 rows=11 width=241) (actual time=0.022..0.056 rows=8 loops=1)
    -> Index Scan using recipe_ingredient_pkey on recipe_ingredient ri (cost=0.43..48.62 rows=11 width=226) (actual time=0.013..0.014 rows=8 loops=1)
        Index Cond: (recipe_id = 45897)
    -> Index Scan using ingredient_pkey on ingredient i (cost=0.29..7.94 rows=1 width=23) (actual time=0.004..0.004 rows=1 loops=1)
        Index Cond: (id = ri.ingredient_id)
Planning Time: 0.479 ms
Execution Time: 0.125 ms
```

3. Времето изменато во извршување на операциите insert и update изнесува.

```
INSERT INTO recipe_ingredient (recipe_id, ingredient_id) VALUES ( 45897, 1);
```

```
Rows: 1 1 row(s) updated - 112ms, on 2026-05-14 at 18:51:57
```

```
UPDATE recipe_ingredient SET quantity = '500' WHERE recipe_id = 45897 AND ingredient_id = 1;
```

```
Rows: 1 1 row(s) updated - 131ms, on 2026-05-14 at 18:56:24
```

4. Оптимизација: Овие погледи ги поврзуваат рецептите со нивните состојки и категории. Користењето на индекси на надворешните клучеви во табелите recipe\_ingredient и recipe\_category ги оптимизира "JOIN" операциите.

```
CREATE INDEX IF NOT EXISTS idx_recipe_ingredient_recipe_id ON recipe_ingredient(recipe_id);
CREATE INDEX IF NOT EXISTS idx_recipe_ingredient_ingredient_id ON recipe_ingredient(ingredient_id);
```

```
select * from public.recipe_ingredients_view where recipe_id=45897
```

Query Plan

Nested Loop (cost=1.14..144.50 rows=11 width=273) (actual time=0.180..0.532 rows=8 loops=1)
-> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.039..0.040 rows=1 loops=1)
Index Cond: (id = 45897)
-> Nested Loop (cost=0.72..135.95 rows=11 width=241) (actual time=0.137..0.485 rows=8 loops=1)
-> Index Scan using recipe_ingredient_pkey on recipe_ingredient ri (cost=0.43..48.62 rows=11 width=226) (actual time=0.085..0.086 rows=11 loops=1)
Index Cond: (recipe_id = 45897)
-> Index Scan using ingredient_pkey on ingredient i (cost=0.29..7.94 rows=1 width=23) (actual time=0.042..0.042 rows=1 loops=1)
Index Cond: (id = ri.ingredient_id)

Planning Time: 1.384 ms  
Execution Time: 0.571 ms

Rows: 1 | 10 row(s) fetched - 80ms

- Иако беа креирани дополнителни индекси над колоните `recipe_id` и `ingredient_id`, не се забележува значителна промена во времето на извршување ниту во execution plan-от. Причината е што базата веќе користи постоечки индекси при извршување на JOIN операциите.
- Времето изминато во извршување на операциите `insert` и `update` по индексирање изнесува:

```
INSERT INTO recipe_ingredient (recipe_id, ingredient_id) VALUES ( 45897, 2);
```

Rows: 1 | 1 row(s) updated - 210ms, on 2026-05-14 at 19:05:30

```
UPDATE recipe_ingredient SET quantity = '100' WHERE recipe_id = 45897 AND ingredient_id = 1;
```

Rows: 1 | 1 row(s) updated - 85ms, on 2026-05-14 at 19:06:40

## View 6: recipe\_reviews\_view

- Примарен филтер: Примарен филтер за овој поглед е `recipe_id` (за прикажување на сите оценки за еден рецепт), а секундарен филтер е `user_id` (за преглед на сите рецензии оставени од еден корисник).
- Случај на употреба: Овој поглед е од витално значење за социјалниот аспект на форумот. Корисниците се потпираат на оцените и искуствата на другите пред да одлучат да готват нешто. Доколку вчитувањето на рецензиите е бавно, корисникот може да ја напушти страницата.
- Иницијално извршување на погледот.

```

explain analyze select * from public.recipe_reviews_view where recipe_id = 1566;

```

ults 1 × Output

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop	(cost=0.71..1829.49 rows=97 width=89)	(actual time=0.129..484.053 rows=103 loops=1)
-> Nested Loop	(cost=0.42..1091.42 rows=97 width=70)	(actual time=0.077..480.233 rows=103 loops=1)
-> Index Scan using recipe_pkey on recipe r	(cost=0.42..8.44 rows=1 width=36)	(actual time=0.040..0.043 rows=1 loops=1)
Index Cond:	(id = 1566)	
-> Seq Scan on recipe_review rr	(cost=0.00..1082.01 rows=97 width=42)	(actual time=0.034..480.139 rows=103 loops=1)
Filter:	(recipe_id = 1566)	
Rows Removed by Filter:	49899	
-> Index Scan using user_pkey on "user" u	(cost=0.29..7.61 rows=1 width=23)	(actual time=0.035..0.035 rows=1 loops=103)
Index Cond:	(id = rr.user_id)	
Planning Time:	20.943 ms	
Execution Time:	484.107 ms	

Save Cancel Script 200 11 Rows: 1 11 row(s) fetched - 554ms

```

explain analyze select * from public.recipe_reviews_view where user_id = 67121;

```

ults 1 × Output

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop	(cost=1.00..25.07 rows=1 width=89)	(actual time=0.086..0.115 rows=4 loops=1)
-> Nested Loop	(cost=0.71..16.75 rows=1 width=70)	(actual time=0.073..0.095 rows=4 loops=1)
-> Index Scan using recipe_review_user_id_recipe_id_key on recipe_review rr	(cost=0.29..8.31 rows=1 width=42)	(actual time=0.000..0.000 rows=1 loops=4)
Index Cond:	(user_id = 67121)	
-> Index Scan using recipe_pkey on recipe r	(cost=0.42..8.44 rows=1 width=36)	(actual time=0.010..0.010 rows=1 loops=4)
Index Cond:	(id = rr.recipe_id)	
-> Index Scan using user_pkey on "user" u	(cost=0.29..8.31 rows=1 width=23)	(actual time=0.004..0.004 rows=1 loops=4)
Index Cond:	(id = 67121)	
Planning Time:	0.743 ms	
Execution Time:	0.151 ms	

Save Cancel Script 200 10 Rows: 1 10 row(s) fetched - 156ms

4. Времето изминато во извршување на операциите insert и update изнесува.

```

INSERT INTO recipe_attempt (user_id, recipe_id, attempted_at) VALUES (1, 5, NOW());
INSERT INTO recipe_review ( user_id, recipe_id, rating, comment)
VALUES ( 1, 5, 5, 'Amazing recipe!');

```

Rows: 1 1 row(s) updated - 161ms, on 2026-05-14 at 19:43:27

```

UPDATE recipe_review SET rating = 3 WHERE recipe_id = 5;

```

1 row(s) updated - 130ms, on 2026-05-14 at 19:58:07

```

UPDATE recipe_review SET rating = 3 WHERE recipe_id = 5 and user_id = 1;

```

1 row(s) updated - 149ms, on 2026-05-14 at 20:00:02

5. Оптимизација: Со цел да се забрза извршуавњето се креираат индекси на recipe\_id и user\_id.

```
CREATE INDEX IF NOT EXISTS idx_recipe_review_recipe_id ON recipe_review(recipe_id);
```

6. 

```
CREATE INDEX IF NOT EXISTS idx_recipe_review_user_id ON recipe_review(user_id);
```

```
select * from public.recipe_reviews_view where user_id = 67121;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop (cost=1.00..25.07 rows=1 width=89) (actual time=0.042..0.071 rows=4 loops=1)

-> Nested Loop (cost=0.71..16.75 rows=1 width=70) (actual time=0.030..0.051 rows=4 loops=1)

-> Index Scan using recipe\_review\_user\_id\_recipe\_id\_key on recipe\_review rr (cost=0.29..8.31 rows=1 width=42) (a

Index Cond: (user\_id = 67121)

-> Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.006..0.006 rows=1

Index Cond: (id = rr.recipe\_id)

-> Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.004..0.004 rows=1 loops

Index Cond: (id = 67121)

Planning Time: 0.436 ms

Execution Time: 0.112 ms

- 7.

```
select * from public.recipe_reviews_view where recipe_id = 1566;
```

ts 1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop (cost=5.75..989.88 rows=97 width=89) (actual time=0.182..6.419 rows=103 loops=1)

-> Nested Loop (cost=5.46..251.81 rows=97 width=70) (actual time=0.135..2.268 rows=103 loops=1)

-> Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.045..0.047 rows=1

Index Cond: (id = 1566)

-> Bitmap Heap Scan on recipe\_review rr (cost=5.04..242.41 rows=97 width=42) (actual time=0.082..2.151 rows=

Recheck Cond: (recipe\_id = 1566)

Heap Blocks: exact=97

-> Bitmap Index Scan on idx\_recipe\_review\_recipe\_id (cost=0.00..5.02 rows=97 width=0) (actual time=0.045..0

Index Cond: (recipe\_id = 1566)

-> Index Scan using user\_pkey on "user" u (cost=0.29..7.61 rows=1 width=23) (actual time=0.038..0.038 rows=1 loops

Index Cond: (id = rr.user\_id)

Planning Time: 1.595 ms

Execution Time: 6.487 ms

Save Cancel Script 200 13 Rows: 1 13 row(s) fetched - 139ms

8. Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```
INSERT INTO recipe_attempt (user_id, recipe_id, attempted_at) VALUES (1, 6, NOW());
```

```
INSERT INTO recipe_review ( user_id, recipe_id, rating, comment)
```

```
VALUES ( 1, 6, 5, 'Amazing recipe!');
```

```
Rows: 1 1 row(s) updated - 170ms, on 2026-05-14 at 20:08:41
```

```
UPDATE recipe_review SET rating = 4 WHERE recipe_id = 6 and user_id = 1;
```

```
Rows: 1 1 row(s) updated - 150ms, on 2026-05-14 at 20:10:07
```

## View 7: user\_favorites\_view

1. Примарен филтер за овој поглед е user\_id.
2. Случај на употреба: Корисниците сакаат брзо да ги видат своите омилените рецепти.
3. Иницијално извршување на погледот.

```
explain analyze select * from user_favorites_view where user_id = 7;
```

```
ts 1 × Output
Enter a SQL expression to filter results (use Ctrl+Space)
QUERY PLAN
Nested Loop (cost=0.99..25.06 rows=1 width=583) (actual time=0.150..0.154 rows=1 loops=1)
-> Nested Loop (cost=0.57..16.62 rows=1 width=27) (actual time=0.119..0.121 rows=1 loops=1)
-> Index Only Scan using recipe_favorite_pkey on recipe_favorite rf (cost=0.28..8.30 rows=1 width=8) (actual time=0.085..0.086 rows=1 loops=1)
Index Cond: (user_id = 7)
Heap Fetches: 0
-> Index Scan using user_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.029..0.031 rows=1 loops=1)
Index Cond: (id = 7)
-> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=560) (actual time=0.028..0.028 rows=1 loops=1)
Index Cond: (id = rf.recipe_id)
Planning Time: 0.715 ms
Execution Time: 0.199 ms
Save Cancel Script
```

Базата користи recipe\_favorite\_pkey за основни пребарувања по корисник.

4. Доколку сакаме да пребаруваме по рецепт кој најмногу пати е зачуван во листата на омилените рецепти ќе го користиме recipe\_id филтерот за пребарување.

```
explain analyze select * from user_favorites_view where recipe_id = 78408;
```

Output

QUERY PLAN

Nested Loop (cost=115.00..2843.52 rows=1000 width=583) (actual time=63.519..97.566 rows=1000 loops=1)

- > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=560) (actual time=0.017..0.021 rows=1 loops=1)
  - Index Cond: (id = 78408)
- > Hash Join (cost=114.58..2825.09 rows=1000 width=27) (actual time=63.499..97.405 rows=1000 loops=1)
  - Hash Cond: (u.id = rf.user\_id)
  - > Seq Scan on "user" u (cost=0.00..2448.00 rows=100000 width=23) (actual time=0.015..21.678 rows=100000 loops=1)
  - > Hash (cost=102.08..102.08 rows=1000 width=8) (actual time=63.469..63.470 rows=1000 loops=1)
    - Buckets: 1024 Batches: 1 Memory Usage: 48kB
    - > Seq Scan on recipe\_favorite rf (cost=0.00..102.08 rows=1000 width=8) (actual time=62.924..63.365 rows=1000 loops=1)
      - Filter: (recipe\_id = 78408)
      - Rows Removed by Filter: 5007

Planning Time: 12.525 ms  
Execution Time: 97.663 ms

Save Cancel Script 200 13 Rows: 1 13 row(s) fetched - 184ms, on 20

5. Времето изминато во извршување на операциите insert и update изнесува.

```
INSERT INTO recipe_favorite (user_id, recipe_id) VALUES (1, 5);
```

Rows: 1 1 row(s) updated - 170ms, on 2026-05-14 at 21:44:35

```
UPDATE recipe_favorite SET user_id = 99 WHERE user_id = 1;
```

Rows: 1 1 row(s) updated - 224ms, on 2026-05-14 at 21:55:11

6. Оптимизација: Со цел да се забрза извршуавњето се креираат индекси на recipe\_id и user\_id.

```
CREATE INDEX idx_recipe_favorite_user_id ON recipe_favorite(user_id);
CREATE INDEX idx_recipe_favorite_recipe_id ON recipe_favorite(recipe_id);
```

```
explain analyze select * from user_favorites_view where user_id = 7;
```

Output

QUERY PLAN

Nested Loop (cost=0.99..25.06 rows=1 width=583) (actual time=0.304..0.309 rows=1 loops=1)

- > Nested Loop (cost=0.57..16.62 rows=1 width=27) (actual time=0.119..0.122 rows=1 loops=1)
  - > Index Only Scan using recipe\_favorite\_pkey on recipe\_favorite rf (cost=0.28..8.30 rows=1 width=8) (actual time=0.053..0.054 rows=1 loops=1)
    - Index Cond: (user\_id = 7)
    - Heap Fetches: 0
  - > Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.060..0.061 rows=1 loops=1)
    - Index Cond: (id = 7)
- > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=560) (actual time=0.182..0.182 rows=1 loops=1)
  - Index Cond: (id = rf.recipe\_id)

Planning Time: 3.499 ms  
Execution Time: 0.472 ms

Save Cancel Script 200 11 Rows: 1 11 row(s) fetched - 63ms (2ms fetch)

8.

```
explain analyze select * from user_favorites_view where recipe_id = 78408;
```

ts 1 x

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

Nested Loop (cost=68.45..2796.98 rows=1000 width=583) (actual time=8.197..338.215 rows=1000 loops=1)

- > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=560) (actual time=0.028..0.032 rows=1 loops=1)  
Index Cond: (id = 78408)
- > Hash Join (cost=68.03..2778.54 rows=1000 width=27) (actual time=8.165..338.019 rows=1000 loops=1)  
Hash Cond: (u.id = rf.user\_id)
- > Seq Scan on "user" u (cost=0.00..2448.00 rows=100000 width=23) (actual time=0.012..317.265 rows=100000 loops=1)
- > Hash (cost=55.53..55.53 rows=1000 width=8) (actual time=8.125..8.126 rows=1000 loops=1)  
Buckets: 1024 Batches: 1 Memory Usage: 48kB
- > Bitmap Heap Scan on recipe\_favorite rf (cost=16.03..55.53 rows=1000 width=8) (actual time=5.829..7.959 rows=1000 loops=1)  
Recheck Cond: (recipe\_id = 78408)  
Heap Blocks: exact=6
- > Bitmap Index Scan on idx\_recipe\_favorite\_recipe\_id (cost=0.00..15.78 rows=1000 width=0) (actual time=0.105..0.105 rows=1000 loops=1)  
Index Cond: (recipe\_id = 78408)

Planning Time: 12.949 ms  
Execution Time: 338.326 ms

Save Cancel Script [Icons] 200 15 Rows: 1 15 row(s) fetched - 494ms

9. Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```
INSERT INTO recipe_favorite (user_id, recipe_id) VALUES (1, 6);
```

```
Rows: 1 1 row(s) updated - 79ms, on 2026-05-14 at 21:58:10
```

```
UPDATE recipe_favorite SET user_id = 1 WHERE user_id = 99;
```

```
Rows: 1 1 row(s) updated - 97ms, on 2026-05-14 at 21:59:07
```

### View 8: forum\_posts\_view

1. Примарен филтер за погледот forum\_posts\_view ќе биде според user\_id.
2. Погледот ќе се користи за прикажување форум објави.
3. Иницијално извршување на погледот.

```

explain analyze select * from forum_posts_view where user_id = 15;

```

Output

QUERY PLAN

Nested Loop (cost=1000.71..17814.53 rows=11 width=591) (actual time=1780.244..3752.739 rows=11 loops=1)

- > Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.013..0.018 rows=1 loops=1)
  - Index Cond: (id = 15)
- > Gather (cost=1000.42..17806.11 rows=11 width=572) (actual time=1780.228..3752.710 rows=11 loops=1)
  - Workers Planned: 3
  - Workers Launched: 3
  - > Nested Loop Left Join (cost=0.42..16805.01 rows=4 width=572) (actual time=2324.256..3740.880 rows=3 loops=4)
    - > Parallel Seq Scan on forumpost fp (cost=0.00..16771.26 rows=4 width=24) (actual time=2324.129..3740.641 rows=3 loops=4)
      - Filter: (user\_id = 15)
      - Rows Removed by Filter: 249998
    - > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=552) (actual time=0.079..0.079 rows=1 loops=11)
      - Index Cond: (id = fp.recipe\_id)

Planning Time: 43.509 ms  
Execution Time: 3752.784 ms

```

explain analyze select * from forum_posts_view where user_id = 56016 and created_at <= '2026-05-15 00:00:00';

```

Output

QUERY PLAN

Nested Loop (cost=1000.71..18620.98 rows=11 width=591) (actual time=0.527..42.871 rows=15 loops=1)

- > Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.016..0.019 rows=1 loops=1)
  - Index Cond: (id = 56016)
- > Gather (cost=1000.42..18612.56 rows=11 width=572) (actual time=0.510..42.843 rows=15 loops=1)
  - Workers Planned: 3
  - Workers Launched: 3
  - > Nested Loop Left Join (cost=0.42..17611.46 rows=4 width=572) (actual time=3.779..28.398 rows=4 loops=4)
    - > Parallel Seq Scan on forumpost fp (cost=0.00..17577.71 rows=4 width=24) (actual time=3.671..28.152 rows=4 loops=4)
      - Filter: ((created\_at <= '2026-05-15 00:00:00'::timestamp without time zone) AND (user\_id = 56016))
      - Rows Removed by Filter: 249997
    - > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=552) (actual time=0.062..0.062 rows=1 loops=15)
      - Index Cond: (id = fp.recipe\_id)

Planning Time: 0.532 ms  
Execution Time: 42.915 ms

4. Времето изминато во извршување на операциите insert и update изнесува.

```
INSERT INTO forumpost (user_id, recipe_id) VALUES ( 1, 2 );
```

Rows: 1 1 row(s) updated - 288ms, on 2026-05-14 at 22:11:49

```
UPDATE forumpost SET created_at = NOW() WHERE id = 1;
```

1 row(s) updated - 64ms, on 2026-05-14 at 22:13:36

```
UPDATE forumpost SET created_at = NOW() where created_at <= '2026-05-01 00:00:00';
```

999999 row(s) updated - 14.10s, on 2026-05-14 at 22:15:01

```
CREATE INDEX idx_forumpost_user_id ON forumpost(user_id);
CREATE INDEX idx_forumpost_created_at ON forumpost(created_at);
```

5. Оптимизација: Со цел да се забрза извршувањето се креираат индекси на recipe\_id и user\_id.

```

explain analyze select * from forum_posts_view where user_id = 15;

```

1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

**Nested Loop Left Join (cost=5.22..148.91 rows=11 width=591) (actual time=0.074..0.163 rows=11 loops=1)**

- > Nested Loop (cost=4.80..56.10 rows=11 width=43) (actual time=0.059..0.082 rows=11 loops=1)
  - > Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.025..0.026 rows=1 loops=1)
    - Index Cond: (id = 15)
  - > Bitmap Heap Scan on forumpost fp (cost=4.51..47.68 rows=11 width=24) (actual time=0.029..0.049 rows=11 loops=1)
    - Recheck Cond: (user\_id = 15)
    - Heap Blocks: exact=11
    - > Bitmap Index Scan on idx\_forumpost\_user\_id (cost=0.00..4.51 rows=11 width=0) (actual time=0.014..0.014 rows=11 loops=1)
      - Index Cond: (user\_id = 15)
  - > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=552) (actual time=0.006..0.006 rows=1 loops=11)
    - Index Cond: (id = fp.recipe\_id)

Planning Time: 0.432 ms  
Execution Time: 0.211 ms

ave Cancel Script | 200 | 13 | Rows: 1 | 13 row(s) fetched - 109ms, c

6.

```

explain analyze select * from forum_posts_view where user_id = 56016 and created_at <= '2026-05-15 00:00:00';

```

1 ×

Enter a SQL expression to filter results (use Ctrl+Space)

QUERY PLAN

**Nested Loop Left Join (cost=5.22..148.94 rows=11 width=591) (actual time=0.195..0.314 rows=15 loops=1)**

- > Nested Loop (cost=4.80..56.13 rows=11 width=43) (actual time=0.174..0.208 rows=15 loops=1)
  - > Index Scan using user\_pkey on "user" u (cost=0.29..8.31 rows=1 width=23) (actual time=0.016..0.017 rows=1 loops=1)
    - Index Cond: (id = 56016)
  - > Bitmap Heap Scan on forumpost fp (cost=4.51..47.71 rows=11 width=24) (actual time=0.154..0.184 rows=15 loops=1)
    - Recheck Cond: (user\_id = 56016)
    - Filter: (created\_at <= '2026-05-15 00:00:00':timestamp without time zone)
    - Heap Blocks: exact=16
    - > Bitmap Index Scan on idx\_forumpost\_user\_id (cost=0.00..4.51 rows=11 width=0) (actual time=0.015..0.015 rows=18 loops=1)
      - Index Cond: (user\_id = 56016)
  - > Index Scan using recipe\_pkey on recipe r (cost=0.42..8.44 rows=1 width=552) (actual time=0.006..0.006 rows=1 loops=15)
    - Index Cond: (id = fp.recipe\_id)

Planning Time: 0.430 ms  
Execution Time: 0.415 ms

ave Cancel Script | 200 | 14 | Rows: 1 | 14 row(s) fetched - 90ms, on 2026-05-16 at 22

7. Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```

INSERT INTO forumpost (user_id, recipe_id) VALUES ( 1, 3 );

```

Rows: 1 | 1 row(s) updated - 96ms, on 2026-05-14 at 22:36:38

```

UPDATE forumpost SET created_at = NOW() where created_at >= '2026-05-15 00:00:00';

```

Rows: 1 | 100 row(s) updated - 160ms, on 2026-05-14 at 22:35:28

## View 9: recipe\_categories\_view

1. Примарен филтер за погледот recipe\_categories\_view ќе биде според recipe\_id и category\_id.
2. Погледот ќе се користи за прикажување категории на рецепти.
3. Иницијално извршување на погледот.

```
explain analyze select * from recipe_categories_view where recipe_id = 775;
```

```
QUERY PLAN
Nested Loop (cost=8.90..30.99 rows=2 width=258) (actual time=0.229..0.235 rows=1 loops=1)
-> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.044..0.045 rows=1 loops=1)
    Index Cond: (id = 775)
-> Hash Join (cost=8.48..22.53 rows=2 width=226) (actual time=0.181..0.186 rows=1 loops=1)
    Hash Cond: (c.id = rc.category_id)
-> Seq Scan on category c (cost=0.00..13.20 rows=320 width=222) (actual time=0.029..0.032 rows=23 loops=1)
-> Hash (cost=8.46..8.46 rows=2 width=8) (actual time=0.137..0.137 rows=1 loops=1)
    Buckets: 1024 Batches: 1 Memory Usage: 9kB
-> Index Only Scan using recipe_category_pkey on recipe_category rc (cost=0.42..8.46 rows=2 width=8) (actual time=0.131..0.132 rows=1 loops=1)
    Index Cond: (recipe_id = 775)
    Heap Fetches: 1
Planning Time: 0.649 ms
Execution Time: 0.277 ms
```

```
explain analyze select * from recipe_categories_view where category_id = 39;
```

```
QUERY PLAN
Nested Loop (cost=4414.44..19347.36 rows=19832 width=258) (actual time=20.741..60.384 rows=20439 loops=1)
-> Index Scan using category_pkey on category c (cost=0.15..8.17 rows=1 width=222) (actual time=0.039..0.045 rows=1 loops=1)
    Index Cond: (id = 39)
-> Gather (cost=4414.30..19140.87 rows=19832 width=40) (actual time=20.698..57.985 rows=20439 loops=1)
    Workers Planned: 3
    Workers Launched: 3
-> Parallel Hash Join (cost=3414.30..16157.67 rows=6397 width=40) (actual time=14.790..46.523 rows=5110 loops=4)
    Hash Cond: (r.id = rc.recipe_id)
-> Parallel Seq Scan on recipe r (cost=0.00..12547.23 rows=74723 width=36) (actual time=0.021..15.035 rows=57910 loops=4)
-> Parallel Hash (cost=3268.47..3268.47 rows=11666 width=8) (actual time=14.397..14.398 rows=5110 loops=4)
    Buckets: 32768 Batches: 1 Memory Usage: 1152kB
-> Parallel Seq Scan on recipe_category rc (cost=0.00..3268.47 rows=11666 width=8) (actual time=0.351..12.590 rows=5110 loops=4)
    Filter: (category_id = 39)
    Rows Removed by Filter: 64266
Planning Time: 0.596 ms
Execution Time: 61.163 ms
```

4. Времето изминато во извршување на операциите insert и update изнесува.

```
INSERT INTO recipe_category( recipe_id, category_id) VALUES ( 4,39);
```

```
Rows: 0 1 row(s) updated - 160ms, on 2026-05-14 at 22:49:33
```

```
UPDATE recipe_category SET category_id = 40 WHERE recipe_id = 775;
```

```
1 row(s) updated - 302ms, on 2026-05-14 at 22:51:10
```

```
CREATE INDEX idx_recipe_category_recipe_id ON recipe_category(recipe_id);  
CREATE INDEX idx_recipe_category_category_id ON recipe_category(category_id);
```

5.

Оптимизација: Со цел да се забрза извршуавњето се креираат индекси на recipe\_id и category\_id.

```
explain analyze select * from recipe_categories_view where category_id = 39;
```

QUERY PLAN

```
Nested Loop (cost=1950.07..16880.88 rows=19832 width=258) (actual time=32.595..224.252 rows=20439 loops=1)  
-> Index Scan using category_pkey on category c (cost=0.15..8.17 rows=1 width=222) (actual time=0.038..0.043 rows=1 loops=1)  
    Index Cond: (id = 39)  
-> Hash Join (cost=1949.92..16674.40 rows=19832 width=40) (actual time=32.554..221.988 rows=20439 loops=1)  
    Hash Cond: (r.id = rc.recipe_id)  
-> Seq Scan on recipe r (cost=0.00..14116.41 rows=231641 width=36) (actual time=0.009..146.101 rows=231641 loops=1)  
-> Hash (cost=1702.02..1702.02 rows=19832 width=8) (actual time=32.316..32.318 rows=20439 loops=1)  
    Buckets: 32768 Batches: 1 Memory Usage: 1055kB  
-> Bitmap Heap Scan on recipe_category rc (cost=226.12..1702.02 rows=19832 width=8) (actual time=1.484..27.605 rows=20439 loops=1)  
    Recheck Cond: (category_id = 39)  
    Heap Blocks: exact=1217  
-> Bitmap Index Scan on idx_recipe_category_category_id (cost=0.00..221.16 rows=19832 width=0) (actual time=1.271..1.273 rows=1217 loops=1)  
    Index Cond: (category_id = 39)
```

Planning Time: 3.706 ms  
Execution Time: 225.314 ms

6.

```
explain analyze select * from recipe_categories_view where recipe_id = 775;
```

QUERY PLAN

```
Nested Loop (cost=8.90..30.99 rows=2 width=258) (actual time=0.273..0.279 rows=1 loops=1)  
-> Index Scan using recipe_pkey on recipe r (cost=0.42..8.44 rows=1 width=36) (actual time=0.126..0.128 rows=1 loops=1)  
    Index Cond: (id = 775)  
-> Hash Join (cost=8.48..22.53 rows=2 width=226) (actual time=0.142..0.146 rows=1 loops=1)  
    Hash Cond: (c.id = rc.category_id)  
-> Seq Scan on category c (cost=0.00..13.20 rows=320 width=222) (actual time=0.012..0.014 rows=23 loops=1)  
-> Hash (cost=8.46..8.46 rows=2 width=8) (actual time=0.100..0.101 rows=1 loops=1)  
    Buckets: 1024 Batches: 1 Memory Usage: 9kB  
-> Index Only Scan using recipe_category_pkey on recipe_category rc (cost=0.42..8.46 rows=2 width=8) (actual time=0.093..0.095 rows=2 loops=1)  
    Index Cond: (recipe_id = 775)  
    Heap Fetches: 1
```

Planning Time: 0.394 ms  
Execution Time: 0.341 ms

7. Времето изминато во извршување на операциите insert и update по индексирање изнесува:

```
INSERT INTO recipe_category( recipe_id, category_id) VALUES ( 5,39);
```

```
Rows: 1 1 row(s) updated - 117ms, on 2026-05-14 at 22:54:58
```

```
UPDATE recipe_category SET category_id = 39 WHERE recipe_id = 775;
```

```
Rows: 1 1 row(s) updated - 159ms, on 2026-05-14 at 22:56:11
```