**Original query**

-> Limit: 50 row(s) (actual time=89139..89139 rows=50 loops=1)

-> Sort: avg\_rating\_amazon DESC (actual time=89139..89139 rows=50 loops=1)

-> Table scan on <temporary> (cost=2.5..2.5 rows=0) (actual time=89139..89139 rows=538 loops=1)

-> Temporary table (cost=0..0 rows=0) (actual time=89139..89139 rows=538 loops=1)

-> Window aggregate: rank() OVER (PARTITION BY pb.genre ORDER BY `avg(perfect\_books.total\_ratings)` desc ) (actual time=89136..89138 rows=538 loops=1)

-> Filter: (`count(distinct amazon\_books.title)` >= 2) (actual time=89136..89137 rows=538 loops=1)

-> Sort: pb.genre, `avg(perfect\_books.total\_ratings)` DESC (actual time=89136..89137 rows=2922 loops=1)

-> Stream results (actual time=89069..89127 rows=2922 loops=1)

-> Group aggregate: count(distinct amazon\_books.title), avg(perfect\_books.total\_ratings), avg(tmp\_field), count(distinct amazon\_books.title), avg(amazon\_books.rating), avg(perfect\_books.rating) (actual time=89069..89121 rows=2922 loops=1)

-> Sort: pb.genre, pb.author (actual time=89069..89075 rows=10950 loops=1)

-> Stream results (cost=10666 rows=675) (actual time=38.2..89000 rows=10950 loops=1)

-> Filter: ((pb.title = ab.title) and (pb.author = ab.author)) (cost=10666 rows=675) (actual time=29.6..175 rows=10950 loops=1)

-> Inner hash join (<hash>(pb.title)=<hash>(ab.title)), (<hash>(pb.author)=<hash>(ab.author)) (cost=10666 rows=675) (actual time=29.6..147 rows=10950 loops=1)

-> Filter: (ab.price is not null) (cost=1.96 rows=68.7) (actual time=0.0327..20.7 rows=7928 loops=1)

-> Table scan on ab (cost=1.96 rows=7630) (actual time=0.0313..18.1 rows=7928 loops=1)

-> Hash

-> Filter: ((pb.rating >= 4) and (pb.total\_ratings > 100)) (cost=1039 rows=1092) (actual time=0.0834..19.9 rows=7342 loops=1)

-> Table scan on pb (cost=1039 rows=9827) (actual time=0.0774..17.5 rows=10000 loops=1)

-> Select #2 (subquery in projection; dependent)

-> Aggregate: count(0) (cost=386 rows=1) (actual time=8.09..8.09 rows=1 loops=10950)

-> Filter: ((apb.author = pb.author) and (apb.rating > 4.5)) (cost=370 rows=164) (actual time=6.66..8.08 rows=1.34 loops=10950)

-> Table scan on apb (cost=370 rows=4932) (actual time=0.0125..6.9 rows=4846 loops=10950)

- Загальний час виконання: 89 139 мс

- Кількість викликів підзапиту: 10 950

- Тимчасові таблиці: так

- Тип доступу: повне сканування

- Індекси не використовуються

**Step 1 refactor**

-> Limit: 50 row(s) (actual time=319..319 rows=50 loops=1)

-> Sort: avg\_rating\_amazon DESC (actual time=319..319 rows=50 loops=1)

-> Table scan on <temporary> (cost=2.5..2.5 rows=0) (actual time=318..318 rows=538 loops=1)

-> Temporary table (cost=0..0 rows=0) (actual time=318..318 rows=538 loops=1)

-> Window aggregate: rank() OVER (PARTITION BY b.genre ORDER BY `avg(perfect\_books.total\_ratings)` desc ) (actual time=314..318 rows=538 loops=1)

-> Filter: (`count(distinct amazon\_books.title)` >= 2) (actual time=314..315 rows=538 loops=1)

-> Sort: b.genre, `avg(perfect\_books.total\_ratings)` DESC (actual time=314..315 rows=2922 loops=1)

-> Stream results (actual time=239..304 rows=2922 loops=1)

-> Group aggregate: count(distinct amazon\_books.title), avg(perfect\_books.total\_ratings), avg(price), count(distinct amazon\_books.title), avg(amazon\_books.amazon\_rating), avg(perfect\_books.perfect\_rating), max(tmp\_field) (actual time=239..298 rows=2922 loops=1)

-> Sort: b.genre, b.author (actual time=239..246 rows=10950 loops=1)

-> Stream results (cost=198421 rows=0) (actual time=53.5..205 rows=10950 loops=1)

-> Nested loop left join (cost=198421 rows=0) (actual time=53.4..175 rows=10950 loops=1)

-> Filter: ((pb.title = ab.title) and (pb.author = ab.author)) (cost=10666 rows=675) (actual time=30.8..116 rows=10950 loops=1)

-> Inner hash join (<hash>(pb.title)=<hash>(ab.title)), (<hash>(pb.author)=<hash>(ab.author)) (cost=10666 rows=675) (actual time=30.8..96.7 rows=10950 loops=1)

-> Filter: (ab.price is not null) (cost=1.96 rows=68.7) (actual time=0.0269..17.8 rows=7928 loops=1)

-> Table scan on ab (cost=1.96 rows=7630) (actual time=0.0256..16.7 rows=7928 loops=1)

-> Hash

-> Filter: ((pb.rating >= 4) and (pb.total\_ratings > 100)) (cost=1039 rows=1092) (actual time=0.0836..20.9 rows=7342 loops=1)

-> Table scan on pb (cost=1039 rows=9827) (actual time=0.0781..18.2 rows=10000 loops=1)

-> Index lookup on ps using <auto\_key0> (author=pb.author) (cost=0.25..2.5 rows=10) (actual time=0.0049..0.00503 rows=0.23 loops=10950)

-> Materialize CTE popular\_stats (cost=0..0 rows=0) (actual time=22.7..22.7 rows=2267 loops=1)

-> Table scan on <temporary> (actual time=17..17.6 rows=2267 loops=1)

-> Aggregate using temporary table (actual time=17..17 rows=2267 loops=1)

-> Filter: (amazon\_popular\_books.rating > 4.5) (cost=517 rows=1644) (actual time=0.015..8.64 rows=3745 loops=1)

-> Table scan on amazon\_popular\_books (cost=517 rows=4932) (actual time=0.014..7.9 rows=4846 loops=1)

- Загальний час виконання: 319 мс

- Кількість викликів підзапиту: 1 (використовується CTE один раз)

- Тимчасові таблиці: так

- Тип доступу: повне сканування

- Індекси не використовуються

**Step 2 indexing**

-> Limit: 50 row(s) (actual time=416..416 rows=50 loops=1)

-> Sort: avg\_rating\_amazon DESC (actual time=416..416 rows=50 loops=1)

-> Table scan on <temporary> (cost=2.5..2.5 rows=0) (actual time=415..416 rows=538 loops=1)

-> Temporary table (cost=0..0 rows=0) (actual time=415..415 rows=538 loops=1)

-> Window aggregate: rank() OVER (PARTITION BY b.genre ORDER BY `avg(perfect\_books.total\_ratings)` desc ) (actual time=413..415 rows=538 loops=1)

-> Filter: (`count(distinct amazon\_books.title)` >= 2) (actual time=413..414 rows=538 loops=1)

-> Sort: b.genre, `avg(perfect\_books.total\_ratings)` DESC (actual time=413..414 rows=2922 loops=1)

-> Stream results (actual time=335..401 rows=2922 loops=1)

-> Group aggregate: count(distinct amazon\_books.title), avg(perfect\_books.total\_ratings), avg(price), count(distinct amazon\_books.title), avg(amazon\_books.amazon\_rating), avg(perfect\_books.perfect\_rating), max(tmp\_field) (actual time=335..394 rows=2922 loops=1)

-> Sort: b.author, b.genre (actual time=335..343 rows=10950 loops=1)

-> Stream results (cost=748596 rows=7.35e+6) (actual time=21.9..300 rows=10950 loops=1)

-> Nested loop left join (cost=748596 rows=7.35e+6) (actual time=21.9..264 rows=10950 loops=1)

-> Nested loop inner join (cost=2777 rows=4469) (actual time=0.132..198 rows=10950 loops=1)

-> Filter: ((pb.rating >= 4) and (pb.total\_ratings > 100)) (cost=1039 rows=3725) (actual time=0.0643..27 rows=7342 loops=1)

-> Table scan on pb (cost=1039 rows=9827) (actual time=0.0605..23 rows=10000 loops=1)

-> Filter: ((ab.price is not null) and (pb.title = ab.title) and (pb.author = ab.author)) (cost=0.333 rows=1.2) (actual time=0.0148..0.0229 rows=1.49 loops=7342)

-> Index lookup on ab using idx\_amazon\_books\_title\_author (title=pb.title, author=pb.author) (cost=0.333 rows=1.33) (actual time=0.013..0.0194 rows=1.5 loops=7342)

-> Index lookup on ps using <auto\_key0> (author=pb.author) (cost=846..849 rows=10) (actual time=0.00543..0.00558 rows=0.23 loops=10950)

-> Materialize CTE popular\_stats (cost=846..846 rows=1644) (actual time=21.7..21.7 rows=2267 loops=1)

-> Group aggregate: count(0) (cost=682 rows=1644) (actual time=0.0351..13.8 rows=2267 loops=1)

-> Filter: (amazon\_popular\_books.rating > 4.5) (cost=517 rows=1644) (actual time=0.021..10.6 rows=3745 loops=1)

-> Covering index scan on amazon\_popular\_books using idx\_popular\_authot\_rating (cost=517 rows=4932) (actual time=0.0198..9.51 rows=4846 loops=1)

- Загальний час виконання: 416 мс

- Кількість викликів підзапиту: 1 (використовується CTE один раз)

- Тимчасові таблиці: так

- Тип доступу: індексне сканування

- Індекси використані: idx\_popular\_author\_rating

**Step 3 Joins**

-> Limit: 50 row(s) (actual time=343..343 rows=50 loops=1)

-> Sort: avg\_rating\_amazon DESC (actual time=343..343 rows=50 loops=1)

-> Table scan on <temporary> (cost=2.5..2.5 rows=0) (actual time=342..342 rows=538 loops=1)

-> Temporary table (cost=0..0 rows=0) (actual time=342..342 rows=538 loops=1)

-> Window aggregate: rank() OVER (PARTITION BY b.genre ORDER BY `avg(perfect\_books.total\_ratings)` desc ) (actual time=339..342 rows=538 loops=1)

-> Filter: (`count(distinct amazon\_books.title)` >= 2) (actual time=339..341 rows=538 loops=1)

-> Sort: b.genre, `avg(perfect\_books.total\_ratings)` DESC (actual time=339..340 rows=2922 loops=1)

-> Stream results (actual time=278..330 rows=2922 loops=1)

-> Group aggregate: count(distinct amazon\_books.title), avg(perfect\_books.total\_ratings), avg(perfect\_books.perfect\_rating), avg(amazon\_books.amazon\_rating), avg(price), count(distinct amazon\_books.title), max(tmp\_field) (actual time=278..325 rows=2922 loops=1)

-> Sort: b.author, b.genre (actual time=278..283 rows=10950 loops=1)

-> Stream results (cost=748596 rows=7.35e+6) (actual time=16.9..251 rows=10950 loops=1)

-> Nested loop left join (cost=748596 rows=7.35e+6) (actual time=16.8..220 rows=10950 loops=1)

-> Nested loop inner join (cost=2777 rows=4469) (actual time=0.118..166 rows=10950 loops=1)

-> Filter: ((pb.rating >= 4) and (pb.total\_ratings > 100) and (pb.title is not null) and (pb.author is not null)) (cost=1039 rows=3725) (actual time=0.0582..22.8 rows=7342 loops=1)

-> Table scan on pb (cost=1039 rows=9827) (actual time=0.0538..19.3 rows=10000 loops=1)

-> Filter: ((pb.title = ab.title) and (pb.author = ab.author) and (ab.price is not null)) (cost=0.333 rows=1.2) (actual time=0.012..0.0191 rows=1.49 loops=7342)

-> Index lookup on ab using idx\_amazon\_books\_title\_author (title=pb.title, author=pb.author) (cost=0.333 rows=1.33) (actual time=0.0105..0.016 rows=1.5 loops=7342)

-> Index lookup on ps using <auto\_key0> (author=pb.author) (cost=846..849 rows=10) (actual time=0.00445..0.00457 rows=0.23 loops=10950)

-> Materialize CTE popular\_stats (cost=846..846 rows=1644) (actual time=16.7..16.7 rows=2267 loops=1)

-> Group aggregate: count(0) (cost=682 rows=1644) (actual time=0.0214..10.7 rows=2267 loops=1)

-> Filter: (amazon\_popular\_books.rating > 4.5) (cost=517 rows=1644) (actual time=0.0121..8.32 rows=3745 loops=1)

-> Covering index scan on amazon\_popular\_books using idx\_popular\_authot\_rating (cost=517 rows=4932) (actual time=0.0115..7.55 rows=4846 loops=1)

- Загальний час виконання: 343 мс

- Кількість викликів підзапиту: 1 (використовується CTE один раз)

- Тимчасові таблиці: так

- Тип доступу: індексне сканування

- Індекси використані: idx\_popular\_author\_rating

**Step 4 index hints**

-> Limit: 50 row(s) (actual time=401..401 rows=50 loops=1)

-> Sort: avg\_rating\_amazon DESC (actual time=401..401 rows=50 loops=1)

-> Table scan on <temporary> (cost=2.5..2.5 rows=0) (actual time=401..401 rows=538 loops=1)

-> Temporary table (cost=0..0 rows=0) (actual time=401..401 rows=538 loops=1)

-> Window aggregate: rank() OVER (PARTITION BY b.genre ORDER BY `avg(perfect\_books.total\_ratings)` desc ) (actual time=398..400 rows=538 loops=1)

-> Filter: (`count(distinct amazon\_books.title)` >= 2) (actual time=398..399 rows=538 loops=1)

-> Sort: b.genre, `avg(perfect\_books.total\_ratings)` DESC (actual time=398..399 rows=2922 loops=1)

-> Stream results (actual time=332..387 rows=2922 loops=1)

-> Group aggregate: count(distinct amazon\_books.title), avg(perfect\_books.total\_ratings), avg(perfect\_books.perfect\_rating), avg(amazon\_books.amazon\_rating), avg(price), count(distinct amazon\_books.title), max(tmp\_field) (actual time=332..382 rows=2922 loops=1)

-> Sort: b.author, b.genre (actual time=332..338 rows=10950 loops=1)

-> Stream results (cost=749768 rows=7.35e+6) (actual time=15.7..302 rows=10950 loops=1)

-> Nested loop left join (cost=749768 rows=7.35e+6) (actual time=15.7..268 rows=10950 loops=1)

-> Nested loop inner join (cost=3949 rows=4469) (actual time=0.124..211 rows=10950 loops=1)

-> Filter: ((pb.total\_ratings > 100) and (pb.title is not null) and (pb.author is not null)) (cost=2211 rows=3725) (actual time=0.0786..42 rows=7342 loops=1)

-> Index range scan on pb using idx\_perfect\_rating over (4 <= rating), with index condition: (pb.rating >= 4) (cost=2211 rows=4913) (actual time=0.0759..38.6 rows=9250 loops=1)

-> Filter: ((pb.title = ab.title) and (pb.author = ab.author) and (ab.price is not null)) (cost=0.333 rows=1.2) (actual time=0.0149..0.0225 rows=1.49 loops=7342)

-> Index lookup on ab using idx\_amazon\_books\_title\_author (title=pb.title, author=pb.author) (cost=0.333 rows=1.33) (actual time=0.0132..0.0192 rows=1.5 loops=7342)

-> Index lookup on ps using <auto\_key0> (author=pb.author) (cost=2055..2058 rows=10) (actual time=0.00463..0.00476 rows=0.23 loops=10950)

-> Materialize CTE popular\_stats (cost=2055..2055 rows=1644) (actual time=15.6..15.6 rows=2267 loops=1)

-> Group aggregate: count(0) (cost=1891 rows=1644) (actual time=0.0292..9.99 rows=2267 loops=1)

-> Filter: (amazon\_popular\_books.rating > 4.5) (cost=1726 rows=1644) (actual time=0.017..7.73 rows=3745 loops=1)

-> Covering index scan on amazon\_popular\_books using idx\_popular\_authot\_rating (cost=1726 rows=4932) (actual time=0.016..7.02 rows=4846 loops=1)

- Загальний час виконання: 401 мс

- Кількість викликів підзапиту: 1 (використовується CTE один раз)

- Тимчасові таблиці: так

- Тип доступу: індекси

- Індекси використані: idx\_perfect\_rating, idx\_popular\_author\_rating, idx\_amazon\_books\_title\_author