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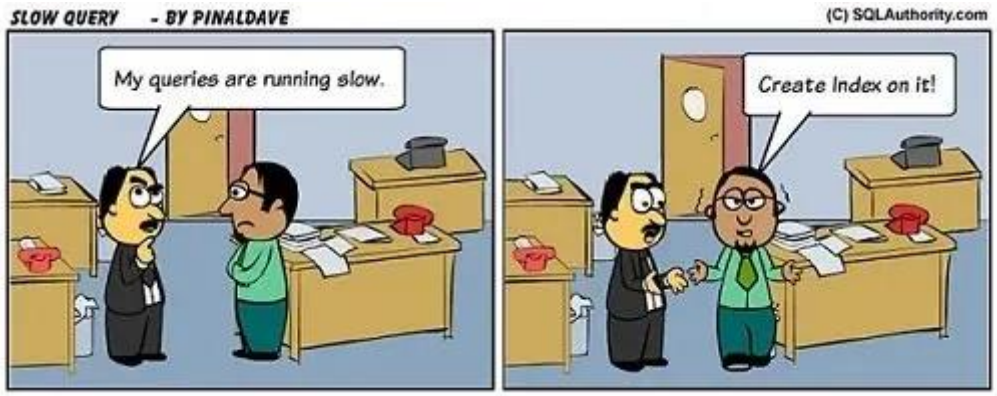


Πριν τρέξουμε ένα query καθαρίζουμε την buffer cache με τις παρακάτω εντολές:

```
CHECKPOINT
DBCC DROPCLEANBUFFERS
```

και ενεργοποιούμε τα Statistics με την εντολή:

```
SET STATISTICS IO ON
```

SQL Notes

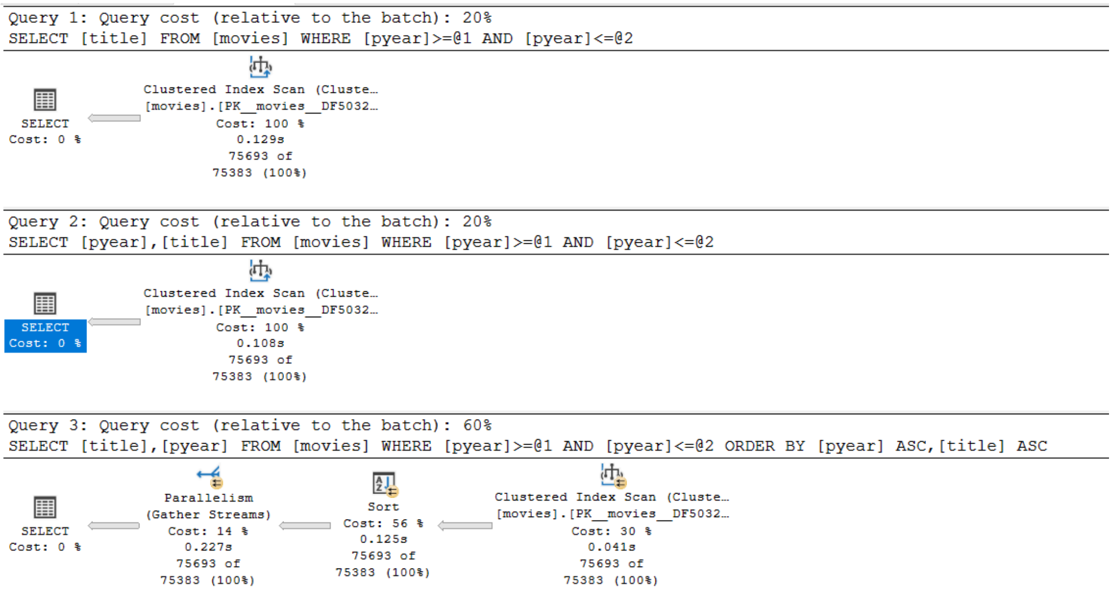
Τα logical reads που εμφανίζονται στα στατιστικά, αναφέρονται σε σελίδες που διαβάζονται από την cache και τα physical reads αναφέρονται σε σελίδες που διαβάζονται από τον δίσκο. Τέλος τα read-ahead reads αναφέρονται σε σελίδες που έρχονται στην cache πριν την εκτέλεση του query.

Ζήτημα Πρώτο

1. Εκτελώντας τα δοσμένα querry με τις εντολές καθαρισμού των buffers και την ενεργοποιήση των στατιστικων, παρατηρούμε πως και τα 3 queries αναφέρονται στα ίδια πεδία του πίνακα movies.
   Πριν το index:

```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'movies'. Scan count 1, logical reads 1918, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'movies'. Scan count 1, logical reads 1918, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 5, logical reads 2012, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T12:58:41.0250939+03:00
```

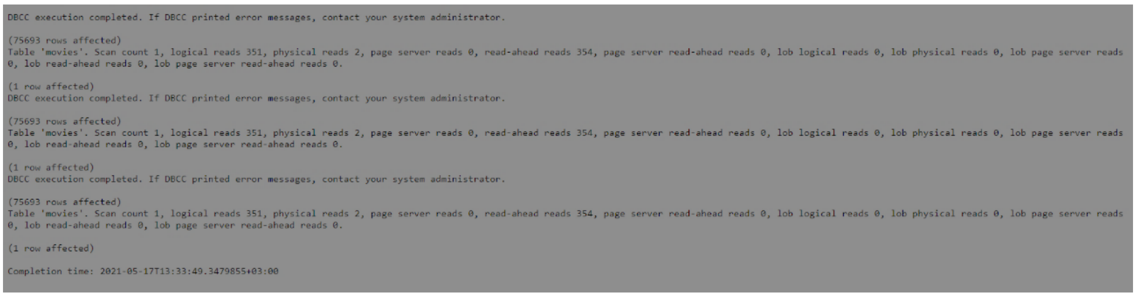
Το execution plan του παραπάνω ερωτήματος είναι το ακόλουθο:



Το I/O Cost για το Index Scan είναι ίσο με 1.41610 για κάθε querry. Στο δεύτερο querry το Index Scan είναι ίσο με το πρώτο, αλλά το Sort I/O Cost είναι 0.0056306.

Επιλέγουμε να φτιάξουμε ευρετήριο για το πεδία title, pyear, καθώς βάσει αυτών γίνεται το ORDER BY.

```
CREATE NONCLUSTERED INDEX index1 ON movies(pyear,title)
```



```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'movies'. Scan count 1, logical reads 351, physical reads 2, page server reads 0, read-ahead reads 354, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'movies'. Scan count 1, logical reads 351, physical reads 2, page server reads 0, read-ahead reads 354, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(75693 rows affected)
Table 'movies'. Scan count 1, logical reads 351, physical reads 2, page server reads 0, read-ahead reads 354, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T13:33:49.3479855+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το ακόλουθο:

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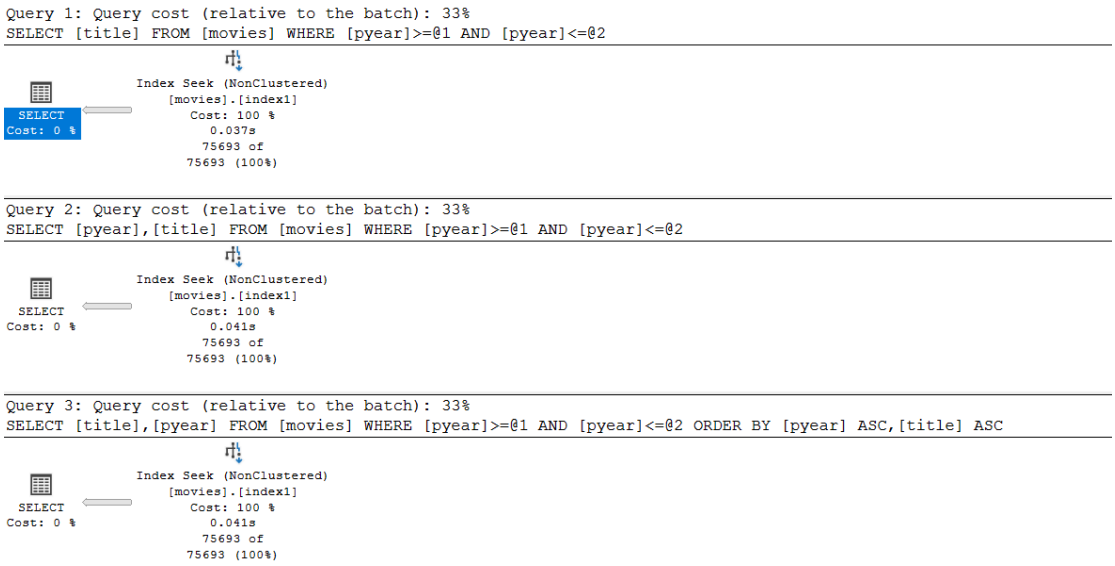
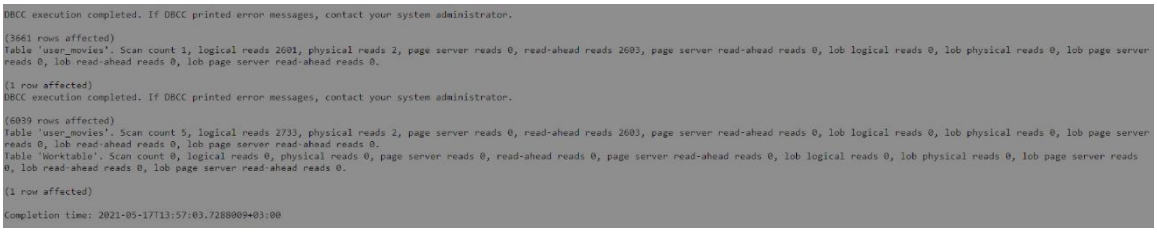
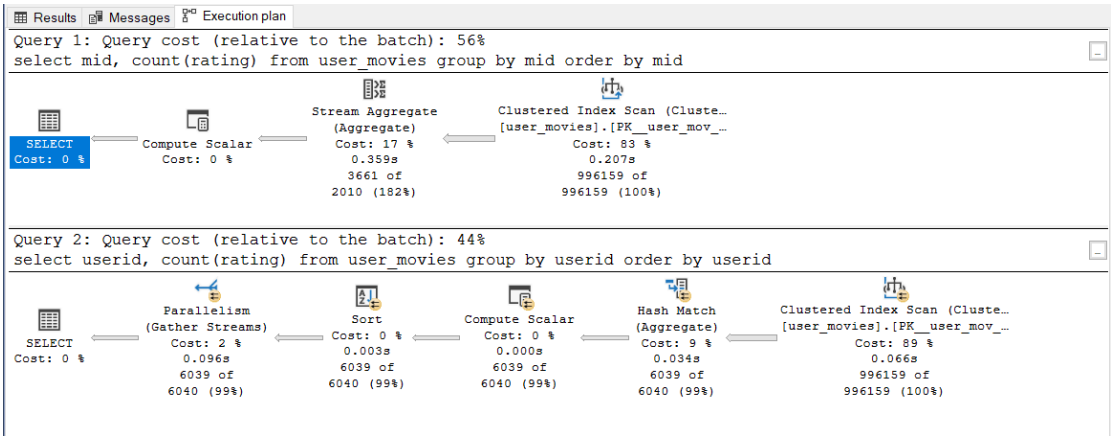


Παρατηρούμε πως μετά την δημιουργία του ευρετηρίου, οι σελίδες που διαβάζονται και από την cache και από τον δίσκο μειώνονται. Ακόμα, το ευρετήριο έρχεται σε μία ισορροπία στο Query Cost για κάθε query, μιας και τώρα γίνεται σωστός διαμοιρασμός του κόστος για όλα τα queries. Το I/O Cost είναι ίσο με 0.254980 για κάθε querry, ενώ δεν γίνεται Sort πλεόν στο δεύτερο. Τέλος, υπάρχει μείωση και στον Execution Time για κάθε query. Συνεπώς το index όντως επιτάχυνε την διαδικασία εκτέλεσης του querry.

2. Αρχικά εκτελούμε το querry χωρίς το ευρετήριο και παίρνουμε τα παρακάτω στατιστικά,



Το execution plan του παραπάνω ερωτήματος είναι το εξής:



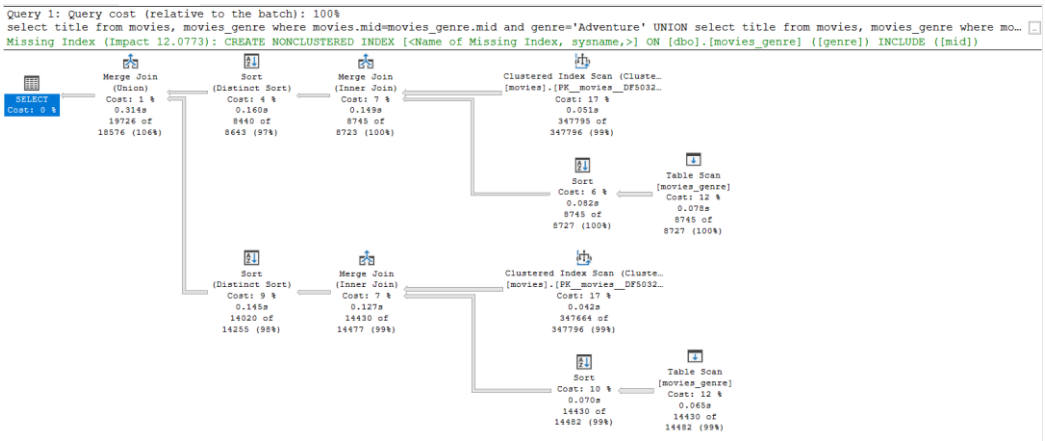
Το I/O Cost είναι ίσο με 1.91942 στο Index Scan για το πρώτο querry, όμοια και το Index Scan του δευτέρου. Το Sort Scan έχει I/O Cost 0.0018769.

Επιλέγουμε να φτιάξουμε ευρετήριο στα πεδία mid,userId καθώς αυτά είναι τα primary keys του πίνακα και βάσει αυτών γίνονται και τα GROUP BY,ORDER BY. Ακόμα επιλέγουμε να κάνουμε INCLUDE το rating για να επιτύχουμε καλύτερη κάλυψη των querries.

```
CREATE INDEX in2 ON user_movies(mid,userid) INCLUDE (rating)
```

```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(3661 rows affected)
Table 'user_movies'. Scan count 1, logical reads 2231, physical reads 1, page server reads 0, read-ahead reads 2252, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(6039 rows affected)
Table 'user_movies'. Scan count 5, logical reads 2342, physical reads 1, page server reads 0, read-ahead reads 2252, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T15:04:45.1486551+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το εξής:



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Το I/O Cost τώρα είναι ίσο με 1.64757 στο Index Scan για το πρώτο querry, όμοια και το Index Scan του δευτέρου. Το Sort Scan έχει I/O Cost 0.0018769.

Παρατηρούμε πως μετά το ευρετήριο, οι σελίδες που διαβάζονται από την cache μειώνονται, όπως και οι σελίδες που διαβάζονται από τον δίσκο. . Τέλος, υπάρχει μείωση και στο Execution Time για κάθε query. Ωστόσο το Execution Plan είναι πιο περίπλοκο. Συνεπώς το index όντως επιτάχυνε την διαδικασία εκτέλεσης, αλλά όχι τόσο αποδοτικά όσο περιμέναμε.

Ζήτημα Δεύτερο

1. Το query που μας δίνεται έχει τα παρακάτω στατιστικά:

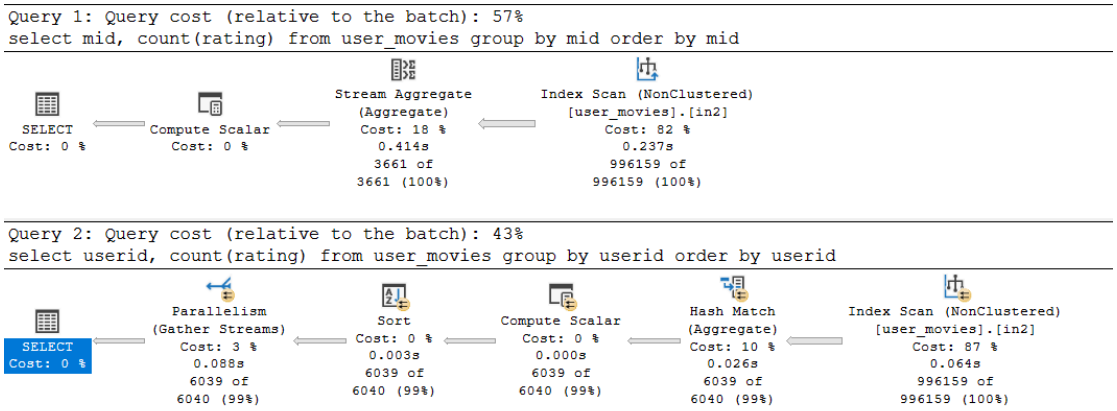
```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(19726 rows affected)
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies_genre'. Scan count 2, logical reads 2748, physical reads 1, page server reads 0, read-ahead reads 1388, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page
server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 2, logical reads 3836, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T15:25:09.5692607+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το εξής:



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Πρέπει να γράψουμε ένα πιο γρήγορο query που να επιστρέφει τα ίδια αποτελέσματα. Μία καλή επιλογή είναι η παρακάτω:

```
SELECT DISTINCT title
FROM movies
INNER JOIN movies_genre ON movies.mid=movies_genre.mid
WHERE genre='Adventure' OR genre='Action'
```

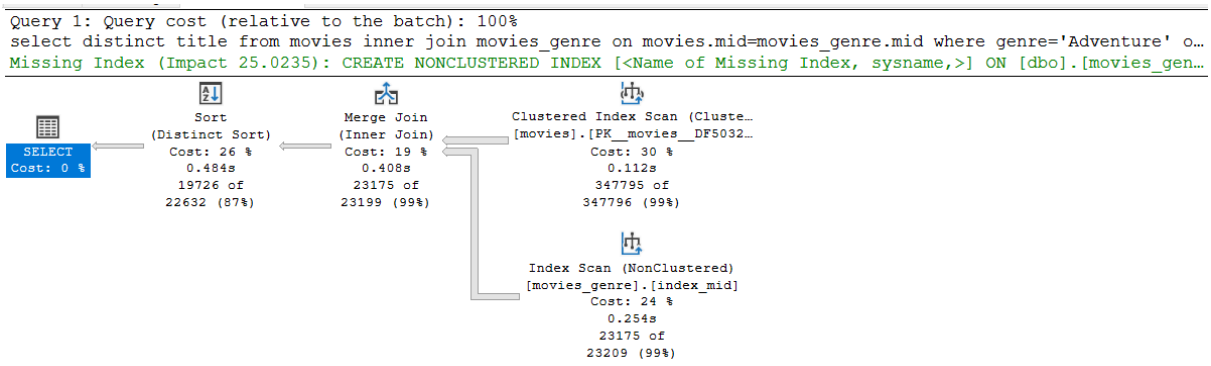
```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(19726 rows affected)
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies_genre'. Scan count 1, logical reads 1374, physical reads 1, page server reads 0, read-ahead reads 1388, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page
server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 1, logical reads 1918, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T15:19:36.6393329+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το εξής:



Το NonClustered Index Scan απαιτεί 1.01275 I/Os, ενώ το Clustered Index Scan απαιτεί 1.4172, τα μισά από όσα είχαμε αρχικά. Αυτό γίνεται γιατί στο πρώτο querry, γίνεται 2 φορές η ίδια διαδικασία, ενώ στο δικό μας querry γίνεται μία. Ακόμα τα logical reads επίσης μειώνονται με την παραλλαγή του αρχικού querry. Οπότε καταλήγουμε στο συμπέρασμα πως όντως το querry που φτιάξαμε είναι πιο αποδοτικό από το αρχικό.

Επιλέγουμε να φτιάξουμε 2 indexes για την επιτάχυνση του querry, ένα για τον πίνακα movies και ένα για τον πίνακα movies_genre. Συνεπώς, οι εντολές που δίνουμε είναι οι ακόλουθες:

```
CREATE NONCLUSTERED INDEX in2 ON movies_genre(genre) INCLUDE (mid)
CREATE NONCLUSTERED INDEX in3 ON movies(title)
```

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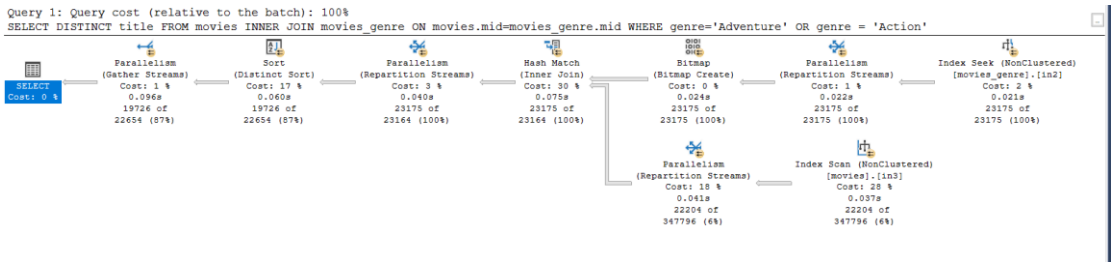
```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(19726 rows affected)
Table 'movies_genre'. Scan count 9, logical reads 95, physical reads 1, page server reads 0, read-ahead reads 84, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 5, logical reads 1479, physical reads 1, page server reads 0, read-ahead reads 1419, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Workfile'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0,
lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T15:37:02.5375053+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το ακόλουθο:



Παρατηρούμε ότι μετά τα ευρετήρια, οι σελίδες που διαβάζονται από την cache καθώς και αυτές που διαβάζονται από τον δίσκο, μειώνονται. Ακόμα μειώνονται και τα read-ahead reads. Επίσης υπάρχει σημαντική μείωση και στο I/O cost. Συνεπώς, καταλήγουμε στο συμπέρασμα πως αυτά τα ευρετήρια βοήθησαν στην επιτάχυνση της εκτέλεσης του querry.

2. Το πρώτο querry είναι το

```
SELECT title
FROM movies
JOIN roles ON movies.mid = roles.mid
JOIN actors ON roles.aid = actors.aid
GROUP BY movies.title
HAVING sum(case when actors.gender = 'F' then 1 else 0 end)=0;
```

```
DBCC execution completed. If DBCC printed error messages, contact your system administrator.

(37846 rows affected)
Table 'movies'. Scan count 5, logical reads 2012, physical reads 2, page server reads 0, read-ahead reads 1917, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'actors'. Scan count 5, logical reads 1171, physical reads 2, page server reads 0, read-ahead reads 1111, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'roles'. Scan count 5, logical reads 4489, physical reads 1, page server reads 0, read-ahead reads 4428, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T18:16:16.7527684+03:00
```

Το execution plan είναι το ακόλουθο:

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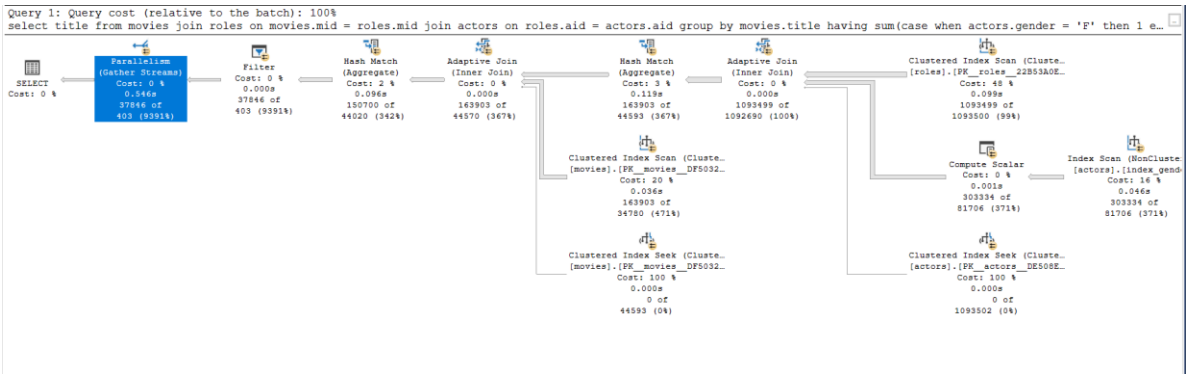


Ένα εναλλακτικό querry που επιστρέφει τα ίδια αποτελέσματα είναι το ακόλουθο:

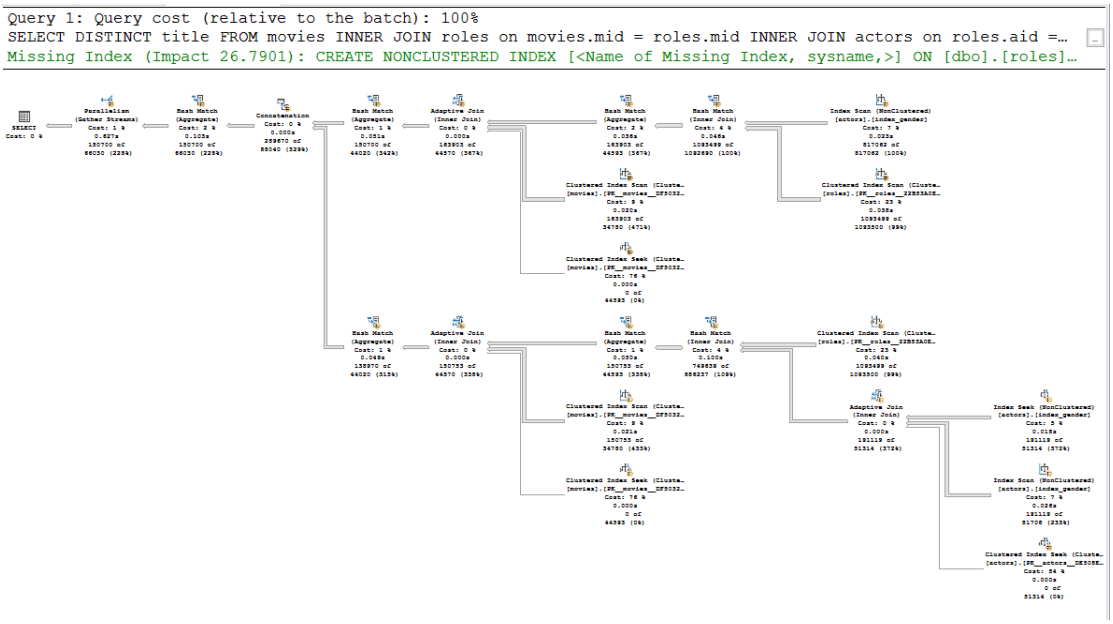
```
SELECT DISTINCT title
FROM movies
INNER JOIN roles on movies.mid = roles.mid
INNER JOIN actors on roles.aid = actors.aid
EXCEPT
SELECT DISTINCT title
FROM movies
INNER JOIN roles on movies.mid = roles.mid
INNER JOIN actors on roles.aid = actors.aid
WHERE(EXISTS(SELECT movies.mid FROM actors
        WHERE movies.mid = roles.mid AND roles.aid = actors.aid   AND actors.gender
        ='F'))
```

```
(37846 rows affected)
Table 'movies'. Scan count 10, logical reads 4024, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'roles'. Scan count 10, logical reads 8978, physical reads 0, page server reads 0, read-ahead reads 4, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'actors'. Scan count 15, logical reads 2781, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T19:27:04.0565955+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το ακόλουθο:



Για το πρώτο querry, επιλέγουμε να φτιάξουμε 3 indexes.

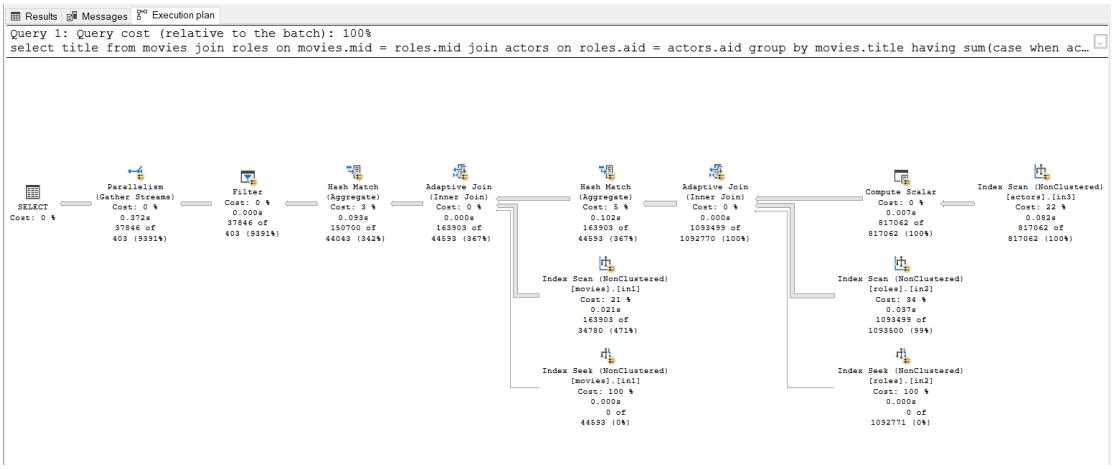
```
CREATE NONCLUSTERED INDEX in1 ON movies(mid) INCLUDE (title)
CREATE NONCLUSTERED INDEX in2 ON roles(aid)
CREATE NONCLUSTERED INDEX in3 ON actors(gender)
```

```
(37846 rows affected)
Table 'movies'. Scan count 5, logical reads 1468, physical reads 0, page server reads 0, read-ahead reads 14, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'roles'. Scan count 5, logical reads 1913, physical reads 0, page server reads 0, read-ahead reads 14, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'actors'. Scan count 5, logical reads 1171, physical reads 0, page server reads 0, read-ahead reads 5, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T19:21:39.8437761+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το ακόλουθο:



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Παρατηρούμε πως και τα logical reads και τα physical reads μειώθηκαν μετά την δημιουργία των ευρετηρίων. Ακόμα μειώθηκαν και τα read-ahead reads. Ωστόσο δεν έχουμε μεγάλη διαφορά στο Execution Plan, οπότε καταλήγουμε στο συμπέρασμα ότι τα ευρετήρια όντως βοήθησαν στην εκτέλεση του querry, αλλά όχι όσο περιμέναμε.

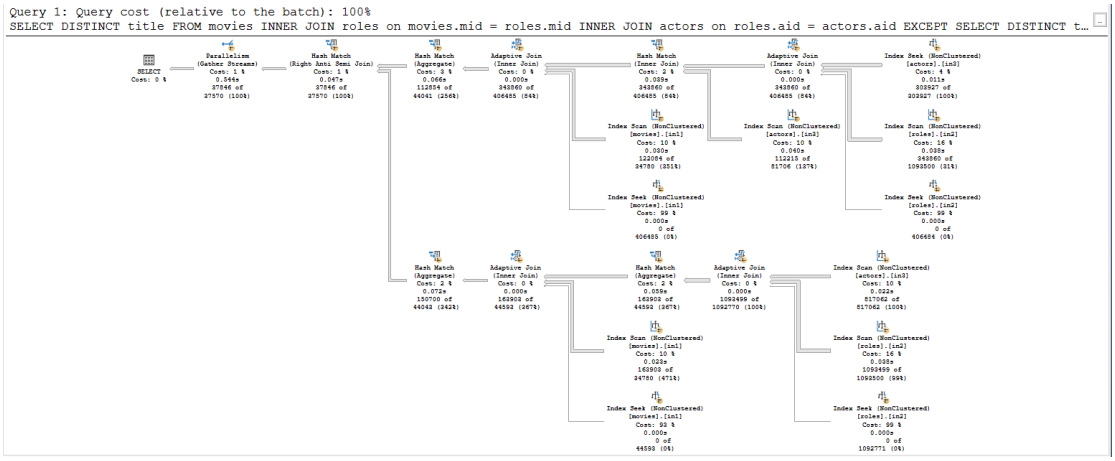
Για το δεύτερο querry, επιλέγουμε τα ίδια ευρετήρια μιας και τα δύο querries που αναφέρθηκαν εκτελούν τους ίδιους υπολογισμούς και επιλέγουν τα ίδια αποτελέσματα. Συνεπώς, μετά την δημιουργία των ευρετηρίων προκύπτουν τα παρακάτω:

```
(37846 rows affected)
Table 'movies'. Scan count 10, logical reads 2936, physical reads 0, page server reads 0, read-ahead reads 7, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'roles'. Scan count 10, logical reads 3826, physical reads 0, page server reads 0, read-ahead reads 7, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'actors'. Scan count 15, logical reads 2781, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T19:28:18.6467732+03:00
```

Το execution plan του παραπάνω ερωτήματος:



Παρατηρούμε ότι μετά την δημιουργία των ευρετηρίων, έχουμε μείωση των σελίδων που διαβάζονται από την cache και από τον δίσκο. Ωστόσο στο Execution Plan δεν υπάρχουν μεγάλες διαφορές, συνεπώς τα ευρετήρια δεν βοήθησαν στον βαθμό που επιθυμούσαμε.

Συμπερασματικά, με βάση τα παραπάνω, καταλήγουμε πως το καλύτερο querry είναι το πρώτο καθώς έχει καλύτερη απόδοση συγκριτικά το δεύτερο για τα ίδια ευρετήρια.

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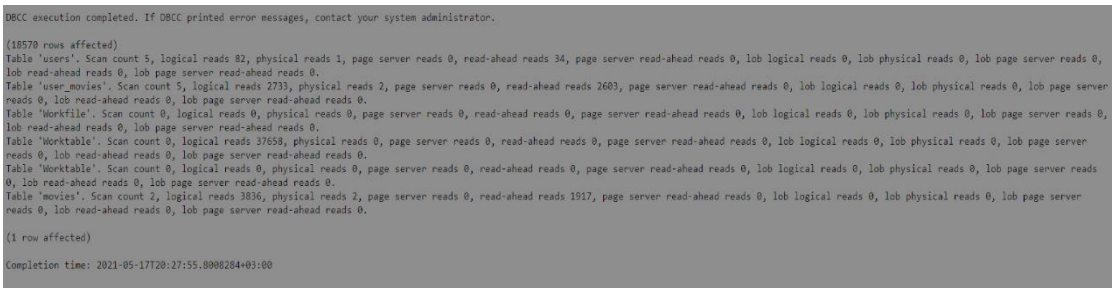
Ζήτημα Τρίτο

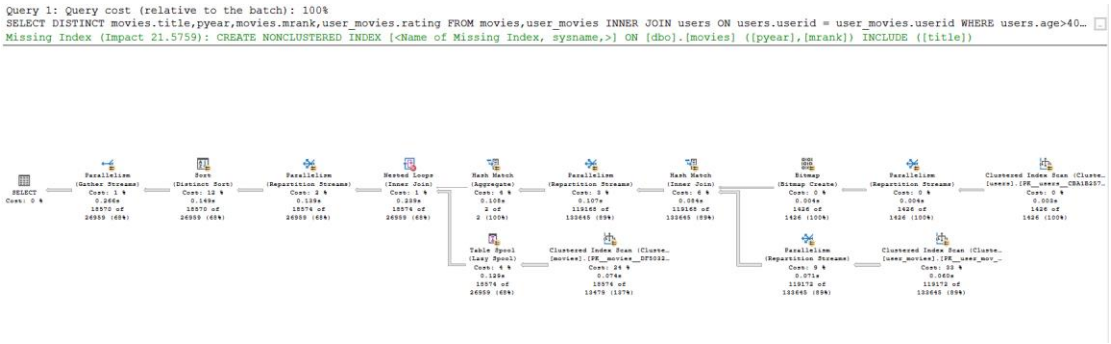
1. Πρώτο Querry:

```
--Ταινίες πριν το 1990, στην 7η και υψηλότερη θέση στην κατάταξη,
 βαθμολογημένες με rating > 3 από ανθρώπους άνω των 40 ετών.

SELECT DISTINCT movies.title,pyear,movies.mrank,user_movies.rating
FROM movies,user_movies
INNER JOIN users ON users.userid = user_movies.userid
WHERE users.age>40 and user_movies.rating>3 and pyear < '1990' and movies.mrank > 7
GROUP BY movies.title,pyear,movies.mrank,user_movies.rating
```



Το execution plan του παραπάνω ερωτήματος:



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Δεύτερο Querry

-- Σκηνοθέτες των οποίων οι ταινίες έχουν βαθμολογηθεί από το κοινό με βαθμό > 3 και το είδος των ταινιών τους είναι είτε Horror, είτε Crime είτε Thriller.

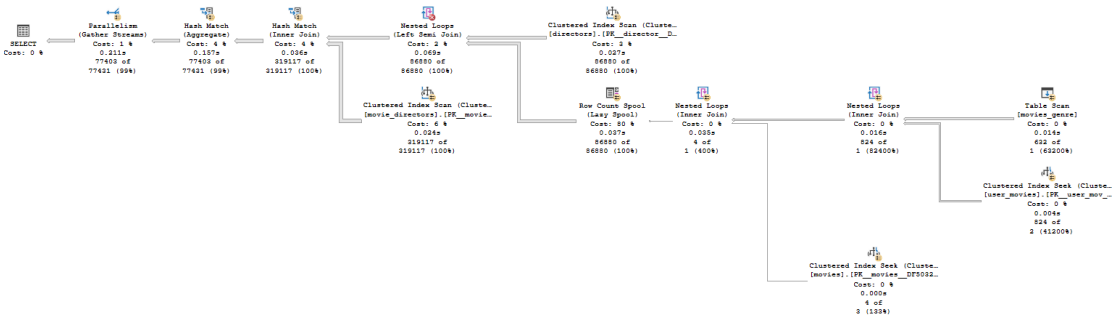
```
SELECT DISTINCT firstName,lastName
FROM directors
INNER JOIN movie_directors ON directors.did = movie_directors.did
WHERE (EXISTS( SELECT rating,user_movies.mid FROM user_movies
INNER JOIN movies ON user_movies.mid = movies.mid
INNER JOIN movies_genre ON user_movies.mid = movies_genre.mid
WHERE rating > 3 and genre = 'Horror' or genre = 'Crime' or genre = 'Thriller'))
GROUP BY firstName,lastName
```

```
(77403 rows affected)
Table 'movie_directors'. Scan count 5, logical reads 708, physical reads 3, page server reads 0, read-ahead reads 671, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 0, logical reads 3300, physical reads 0, page server reads 0, read-ahead reads 2, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'user_movies'. Scan count 632, logical reads 2120, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies_genre'. Scan count 4, logical reads 28, physical reads 0, page server reads 0, read-ahead reads 287, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'directors'. Scan count 5, logical reads 1048, physical reads 1, page server reads 0, read-ahead reads 349, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T20:23:12.4551486+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το παρακάτω:



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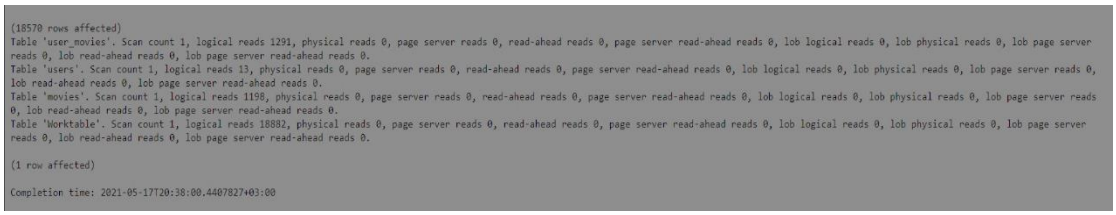
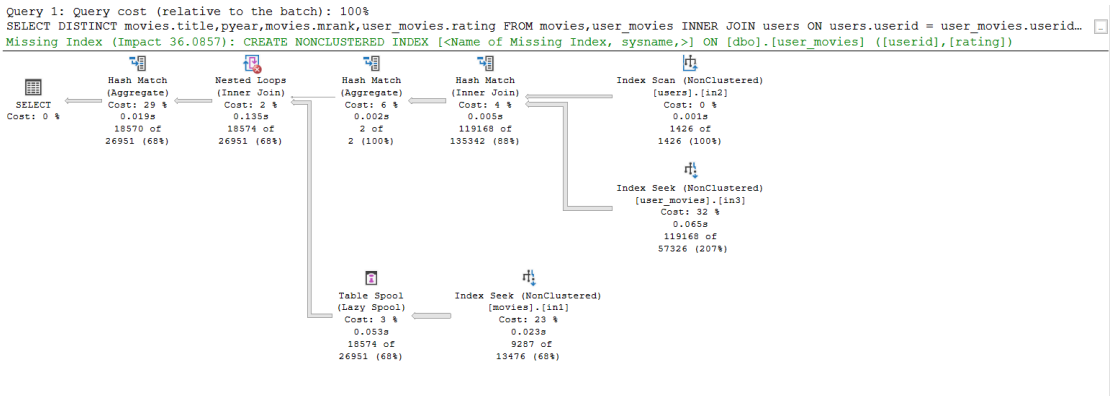
2. Για το πρώτο querry επιλέγουμε να δημιουργήσουμε τα 3 παρακάτω indexes

```
CREATE NONCLUSTERED INDEX in1 ON movies(pyear,mrank) include (title)
CREATE NONCLUSTERED INDEX in2 ON users(userId) include (age)
CREATE NONCLUSTERED INDEX in3 ON user_movies(rating) include (userid)
```



Το execution plan του παραπάνω ερωτήματος είναι το εξής:



Παρατηρούμε ότι μετά τα ευρετήρια έχουμε μείωση των σελίδων που διαβάζονται από την cache και από τον δίσκο. Ακόμα το Execution Plan, είναι πολύ πιο απλό, συνεπώς τα συγκεκριμένα ευρετήρια όντως βοήθησαν στην βελτίωση του querry.

Για το δεύτερο querry, επιλέγουμε τα παρακάτω ευρετήρια:

```
CREATE NONCLUSTERED INDEX in1 ON directors(firstName,lastName) include (did)
CREATE NONCLUSTERED INDEX in2 ON user_movies(mid)
CREATE NONCLUSTERED INDEX in3 ON movies_genre(mid) include (genre)
CREATE NONCLUSTERED INDEX in4 ON movie_directors(did)
```

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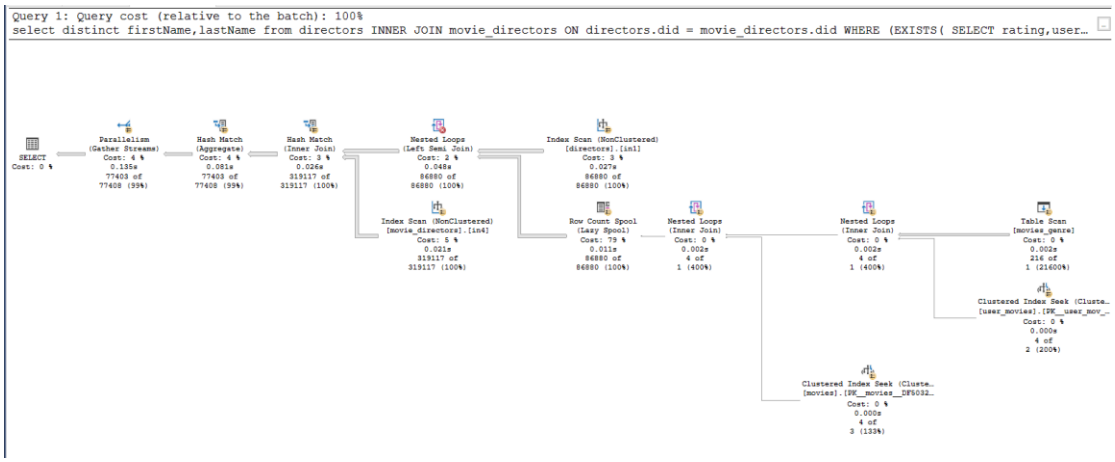
```
(77403 rows affected)
Table 'movie_directors'. Scan count 5, logical reads 585, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies'. Scan count 0, logical reads 16, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads 0,
lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'user_movies'. Scan count 216, logical reads 792, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'movies_genre'. Scan count 4, logical reads 12, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'directors'. Scan count 5, logical reads 1282, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server
reads 0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.
Table 'Worktable'. Scan count 0, logical reads 0, physical reads 0, page server reads 0, read-ahead reads 0, page server read-ahead reads 0, lob logical reads 0, lob physical reads 0, lob page server reads
0, lob read-ahead reads 0, lob page server read-ahead reads 0.

(1 row affected)

Completion time: 2021-05-17T21:02:05.3533795+03:00
```

Το execution plan του παραπάνω ερωτήματος είναι το παρακάτω:



Παρατηρούμε ότι μετά τα ευρετήρια υπάρχει και εδώ μείωση των σελίδων που διαβάζονται και από την cache και από τον δίσκο. Ακόμα το Execution Plan, είναι επίσης πολύ πιο απλό συγκριτικά με το αρχικό. Συνεπώς τα συγκεκριμένα ευρετήρια βοήθησαν στην βελτίωση της απόδοσης του querry.