Assignment 1

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1 Introduction

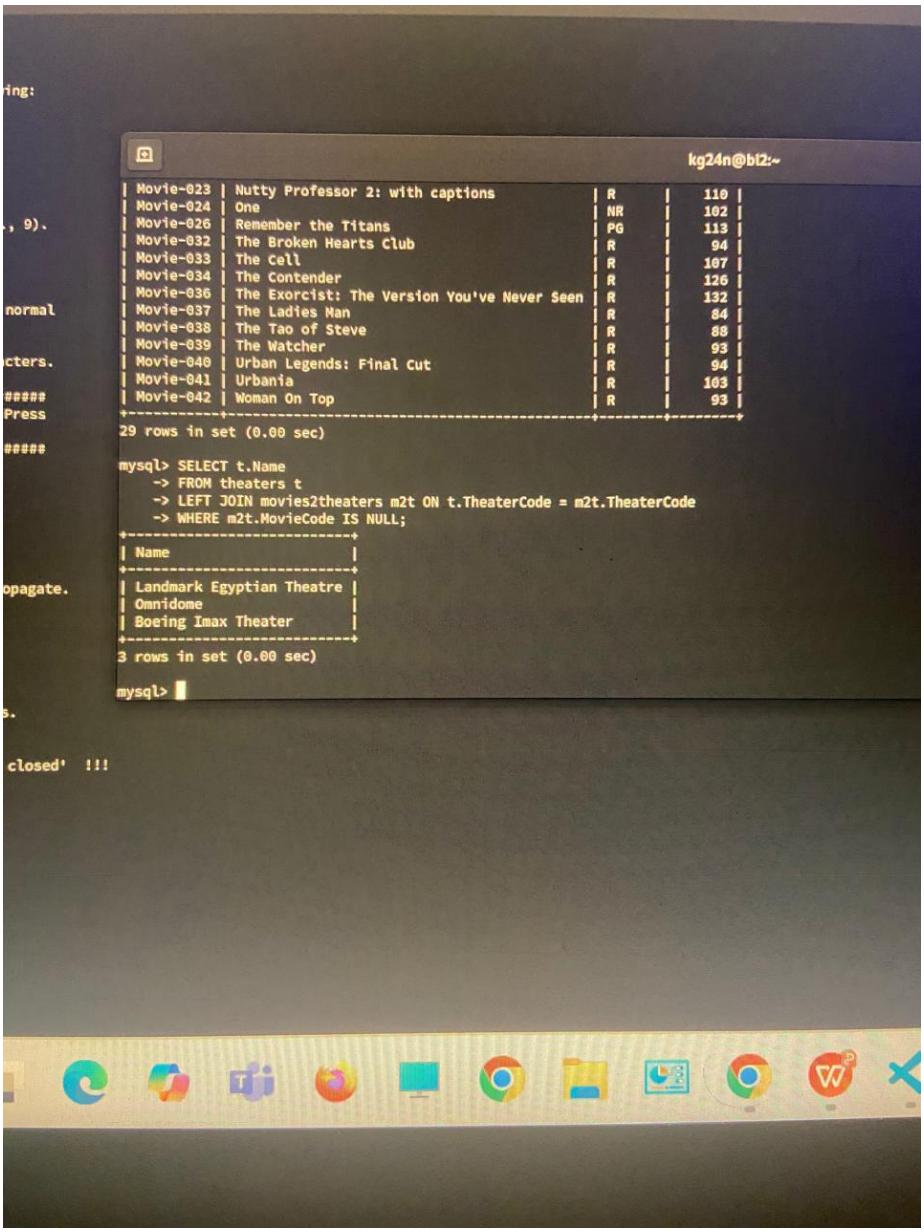
This document contains SQL queries and relational algebra expressions for various database-related questions of Assignment 1. Screenshots of query execution are also provided which were executed on the bl2 system.

2 Question 1: Theaters That Do Not Play Any Movies

SQL Query:

```
SELECT t.Name
FROM theaters t
LEFT JOIN movies2theaters m2t ON t.TheaterCode = m2t.TheaterCode
WHERE m2t.MovieCode IS NULL;
```

Execution Screenshot:



3 Question 2: Relational Algebra Expression for Question 1

Relational Algebra Expression:

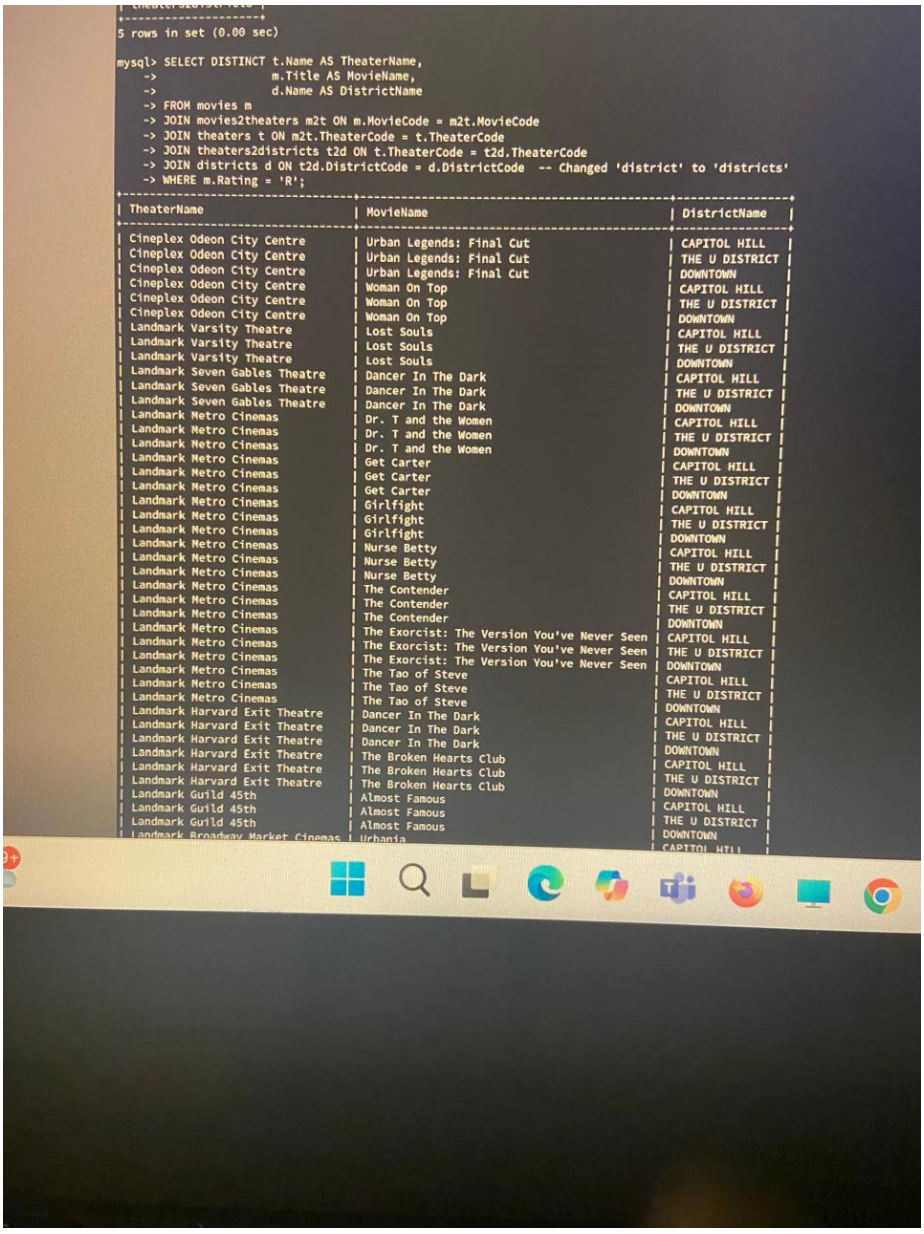
$\pi_{Name}(theaters) - \pi_{Name}(\sigma_{theaters.TheaterCode \in \pi_{TheaterCode}(movies2theaters)}(theaters))$

4 Question 3: Distinct Theater, Movie, and District for 'R' Rated Movies

SQL Query:

```
SELECT DISTINCT t.Name AS TheaterName,
                m.Title AS MovieName,
                d.Name AS DistrictName
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
WHERE m.Rating = 'R';
```

Execution Screenshot:



```
+--------------------+
5 rows in set (0.00 sec)

mysql> SELECT DISTINCT t.Name AS TheaterName,
    ->                 m.Title AS MovieName,
    ->                 d.Name AS DistrictName
    -> FROM movies m
    -> JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
    -> JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
    -> JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
    -> JOIN districts d ON t2d.DistrictCode = d.DistrictCode  -- Changed 'district' to 'districts'
    -> WHERE m.Rating = 'R';
+-------------------------------+-----------------------------------------+--------------+
| TheaterName                   | MovieName                               | DistrictName |
+-------------------------------+-----------------------------------------+--------------+
| Cineplex Odeon City Centre    | Urban Legends: Final Cut                | CAPITOL HILL |
| Cineplex Odeon City Centre    | Urban Legends: Final Cut                | THE U DISTRICT |
| Cineplex Odeon City Centre    | Urban Legends: Final Cut                | DOWNTOWN |
| Cineplex Odeon City Centre    | Woman On Top                            | CAPITOL HILL |
| Cineplex Odeon City Centre    | Woman On Top                            | THE U DISTRICT |
| Cineplex Odeon City Centre    | Woman On Top                            | DOWNTOWN |
| Landmark Varsity Theatre      | Lost Souls                              | CAPITOL HILL |
| Landmark Varsity Theatre      | Lost Souls                              | THE U DISTRICT |
| Landmark Varsity Theatre      | Lost Souls                              | DOWNTOWN |
| Landmark Seven Gables Theatre | Dancer In The Dark                      | CAPITOL HILL |
| Landmark Seven Gables Theatre | Dancer In The Dark                      | THE U DISTRICT |
| Landmark Seven Gables Theatre | Dancer In The Dark                      | DOWNTOWN |
| Landmark Metro Cinemas        | Dr. T and the Women                     | CAPITOL HILL |
| Landmark Metro Cinemas        | Dr. T and the Women                     | THE U DISTRICT |
| Landmark Metro Cinemas        | Dr. T and the Women                     | DOWNTOWN |
| Landmark Metro Cinemas        | Get Carter                              | CAPITOL HILL |
| Landmark Metro Cinemas        | Get Carter                              | THE U DISTRICT |
| Landmark Metro Cinemas        | Get Carter                              | DOWNTOWN |
| Landmark Metro Cinemas        | Girlfight                               | CAPITOL HILL |
| Landmark Metro Cinemas        | Girlfight                               | THE U DISTRICT |
| Landmark Metro Cinemas        | Girlfight                               | DOWNTOWN |
| Landmark Metro Cinemas        | Nurse Betty                             | CAPITOL HILL |
| Landmark Metro Cinemas        | Nurse Betty                             | THE U DISTRICT |
| Landmark Metro Cinemas        | Nurse Betty                             | DOWNTOWN |
| Landmark Metro Cinemas        | The Contender                           | CAPITOL HILL |
| Landmark Metro Cinemas        | The Contender                           | THE U DISTRICT |
| Landmark Metro Cinemas        | The Contender                           | DOWNTOWN |
| Landmark Metro Cinemas        | The Exorcist: The Version You've Never Seen | CAPITOL HILL |
| Landmark Metro Cinemas        | The Exorcist: The Version You've Never Seen | THE U DISTRICT |
| Landmark Metro Cinemas        | The Exorcist: The Version You've Never Seen | DOWNTOWN |
| Landmark Metro Cinemas        | The Tao of Steve                        | CAPITOL HILL |
| Landmark Metro Cinemas        | The Tao of Steve                        | THE U DISTRICT |
| Landmark Metro Cinemas        | The Tao of Steve                        | DOWNTOWN |
| Landmark Harvard Exit Theatre | Dancer In The Dark                      | CAPITOL HILL |
| Landmark Harvard Exit Theatre | Dancer In The Dark                      | THE U DISTRICT |
| Landmark Harvard Exit Theatre | Dancer In The Dark                      | DOWNTOWN |
| Landmark Harvard Exit Theatre | The Broken Hearts Club                  | CAPITOL HILL |
| Landmark Harvard Exit Theatre | The Broken Hearts Club                  | THE U DISTRICT |
| Landmark Harvard Exit Theatre | The Broken Hearts Club                  | DOWNTOWN |
| Landmark Guild 45th           | Almost Famous                           | CAPITOL HILL |
| Landmark Guild 45th           | Almost Famous                           | THE U DISTRICT |
| Landmark Guild 45th           | Almost Famous                           | DOWNTOWN |
| Landmark Broadway Market Cinemas | Urbania                              | CAPITOL HILL |
```

5 Question 4: Relational Algebra Expression for Question 3

Relational Algebra Expression:

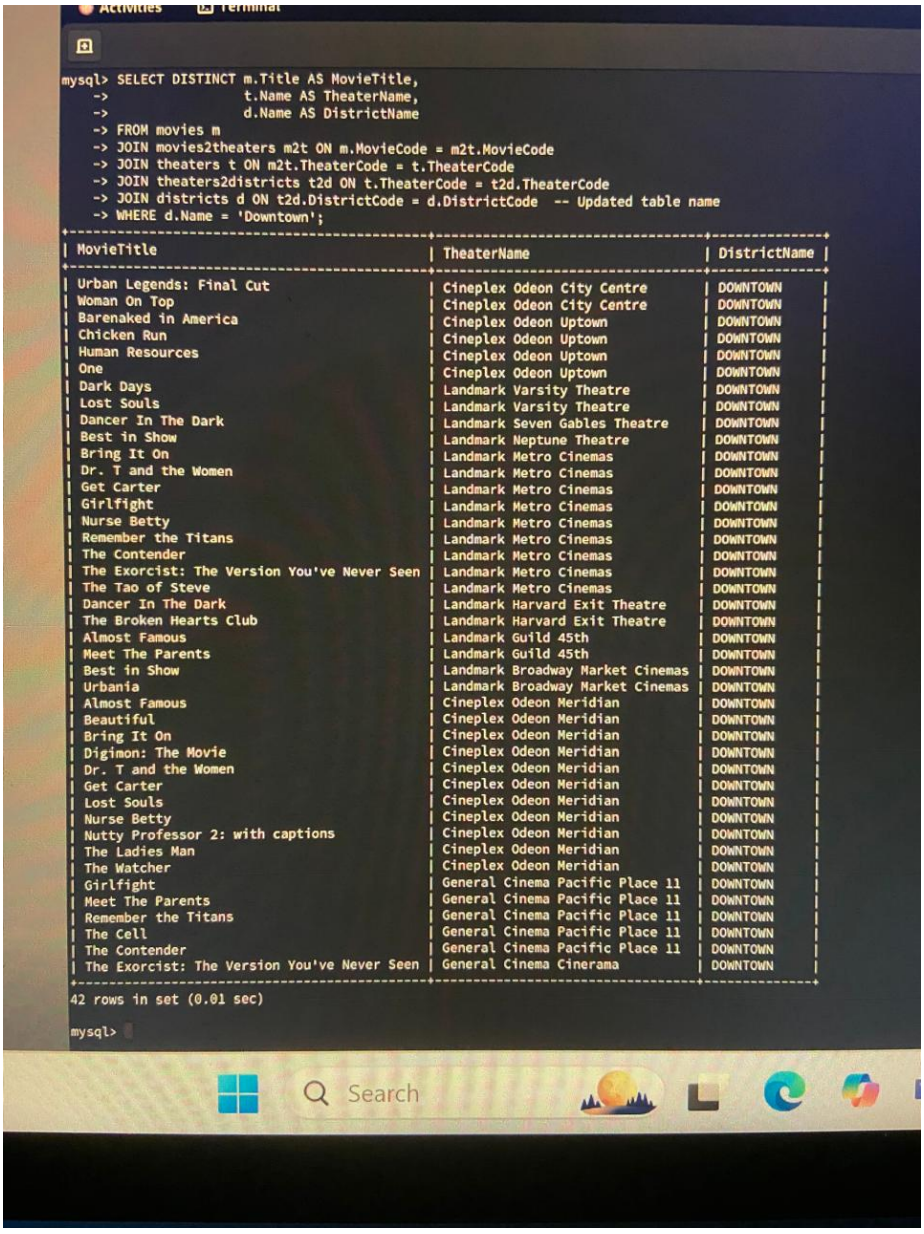
$$\pi_{TheaterName,MovieName,DistrictName}\big(\sigma_{Rating='R'}(movies) \bowtie movies2theaters \bowtie theaters \bowtie theaters2districts \bowtie districts\big)$$

6 Question 5: Movies Played in 'Downtown'

SQL Query:

```
SELECT DISTINCT m.Title AS MovieTitle,
                t.Name AS TheaterName,
                d.Name AS DistrictName
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
WHERE d.Name = 'Downtown';
```

Execution Screenshot:



```
mysql> SELECT DISTINCT m.Title AS MovieTitle,
    ->                 t.Name AS TheaterName,
    ->                 d.Name AS DistrictName
    -> FROM movies m
    -> JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
    -> JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
    -> JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
    -> JOIN districts d ON t2d.DistrictCode = d.DistrictCode  -- Updated table name
    -> WHERE d.Name = 'Downtown';
+-----------------------------------------+-----------------------------+--------------+
| MovieTitle                              | TheaterName                 | DistrictName |
+-----------------------------------------+-----------------------------+--------------+
| Urban Legends: Final Cut                | Cineplex Odeon City Centre  | DOWNTOWN     |
| Woman On Top                            | Cineplex Odeon City Centre  | DOWNTOWN     |
| Barenaked in America                    | Cineplex Odeon Uptown       | DOWNTOWN     |
| Chicken Run                             | Cineplex Odeon Uptown       | DOWNTOWN     |
| Human Resources                         | Cineplex Odeon Uptown       | DOWNTOWN     |
| One                                     | Cineplex Odeon Uptown       | DOWNTOWN     |
| Dark Days                               | Landmark Varsity Theatre    | DOWNTOWN     |
| Lost Souls                              | Landmark Varsity Theatre    | DOWNTOWN     |
| Dancer In The Dark                      | Landmark Seven Gables Theatre | DOWNTOWN   |
| Best in Show                            | Landmark Neptune Theatre    | DOWNTOWN     |
| Bring It On                             | Landmark Metro Cinemas      | DOWNTOWN     |
| Dr. T and the Women                     | Landmark Metro Cinemas      | DOWNTOWN     |
| Get Carter                              | Landmark Metro Cinemas      | DOWNTOWN     |
| Girlfight                               | Landmark Metro Cinemas      | DOWNTOWN     |
| Nurse Betty                             | Landmark Metro Cinemas      | DOWNTOWN     |
| Remember the Titans                     | Landmark Metro Cinemas      | DOWNTOWN     |
| The Contender                           | Landmark Metro Cinemas      | DOWNTOWN     |
| The Exorcist: The Version You've Never Seen | Landmark Metro Cinemas  | DOWNTOWN     |
| The Tao of Steve                        | Landmark Metro Cinemas      | DOWNTOWN     |
| Dancer In The Dark                      | Landmark Harvard Exit Theatre | DOWNTOWN   |
| The Broken Hearts Club                  | Landmark Harvard Exit Theatre | DOWNTOWN   |
| Almost Famous                           | Landmark Guild 45th         | DOWNTOWN     |
| Meet The Parents                        | Landmark Guild 45th         | DOWNTOWN     |
| Best in Show                            | Landmark Broadway Market Cinemas | DOWNTOWN |
| Urbania                                 | Landmark Broadway Market Cinemas | DOWNTOWN |
| Almost Famous                           | Cineplex Odeon Meridian     | DOWNTOWN     |
| Beautiful                               | Cineplex Odeon Meridian     | DOWNTOWN     |
| Bring It On                             | Cineplex Odeon Meridian     | DOWNTOWN     |
| Digimon: The Movie                      | Cineplex Odeon Meridian     | DOWNTOWN     |
| Dr. T and the Women                     | Cineplex Odeon Meridian     | DOWNTOWN     |
| Get Carter                              | Cineplex Odeon Meridian     | DOWNTOWN     |
| Lost Souls                              | Cineplex Odeon Meridian     | DOWNTOWN     |
| Nurse Betty                             | Cineplex Odeon Meridian     | DOWNTOWN     |
| Nutty Professor 2: with captions        | Cineplex Odeon Meridian     | DOWNTOWN     |
| The Ladies Man                          | Cineplex Odeon Meridian     | DOWNTOWN     |
| The Watcher                             | Cineplex Odeon Meridian     | DOWNTOWN     |
| Girlfight                               | General Cinema Pacific Place 11 | DOWNTOWN |
| Meet The Parents                        | General Cinema Pacific Place 11 | DOWNTOWN |
| Remember the Titans                     | General Cinema Pacific Place 11 | DOWNTOWN |
| The Cell                                | General Cinema Pacific Place 11 | DOWNTOWN |
| The Contender                           | General Cinema Pacific Place 11 | DOWNTOWN |
| The Exorcist: The Version You've Never Seen | General Cinema Cinerama | DOWNTOWN     |
+-----------------------------------------+-----------------------------+--------------+
42 rows in set (0.01 sec)

mysql>
```

7 Question 6: Relational Algebra Expression for Question 5

Relational Algebra Expression:

$$\pi_{MovieTitle,TheaterName,DistrictName}\big(\sigma_{DistrictName='Downtown'}(movies \bowtie movies2theaters \bowtie theaters \bowtie theaters2districts \bowtie districts)\big)$$

8 Question 7: Query Plan/Tree

Query Execution Plan:

```
EXPLAIN SELECT DISTINCT m.Title AS MovieTitle,
                t.Name AS TheaterName,
                d.Name AS DistrictName
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
WHERE d.Name = 'Downtown';
```

Query Execution Tree:

```
 (DISTINCT MovieTitle, TheaterName, DistrictName)
  |
   (DistrictName = 'Downtown')
  |
   (movies.MovieCode = movies2theaters.MovieCode)
      |
       (movies2theaters.TheaterCode = theaters.TheaterCode)
          |
           (theaters.TheaterCode = theaters2districts.TheaterCode)
              |
               (theaters2districts.DistrictCode = districts.DistrictCode)
```

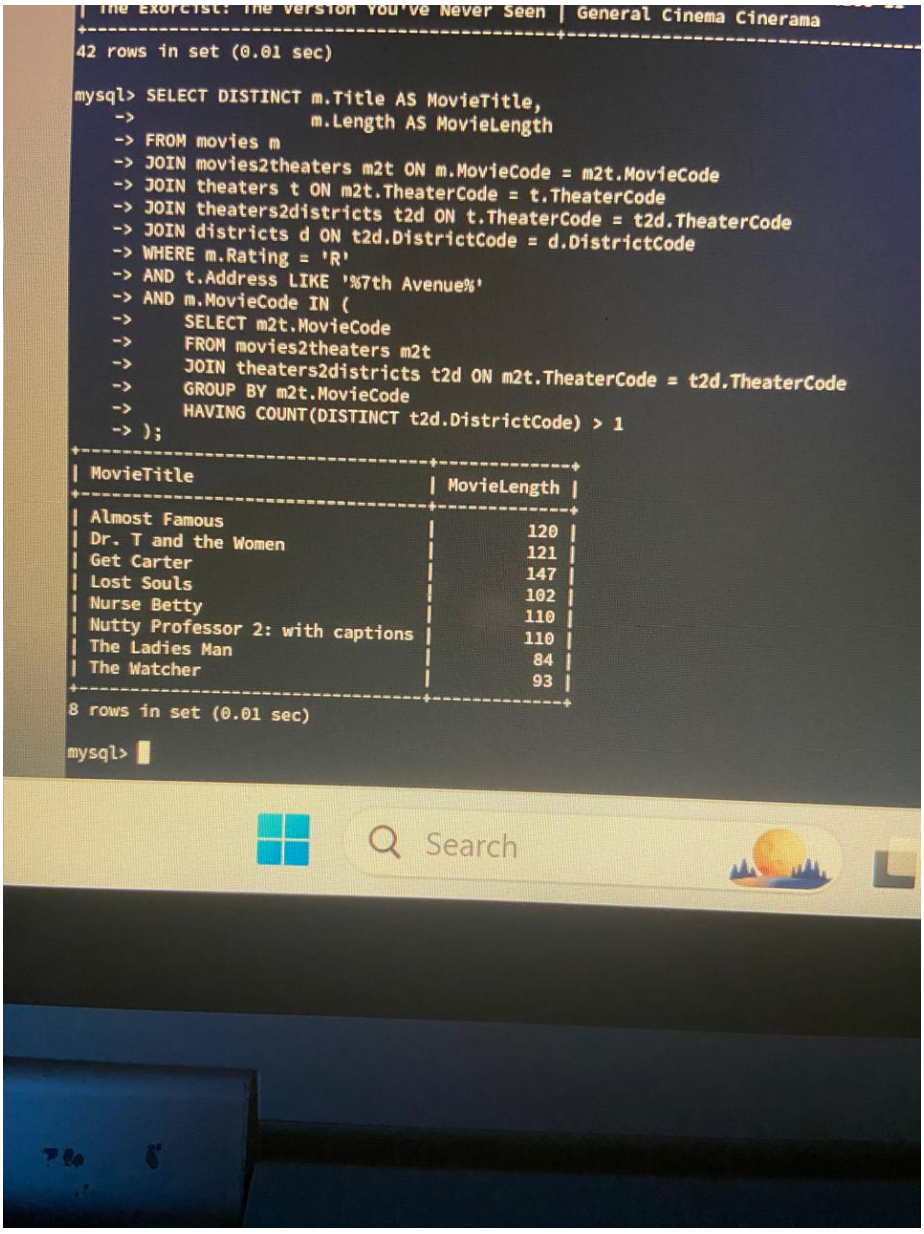
9 Question 8: Movies Over 100 Minutes in Multiple Districts

SQL Query:

```
SELECT DISTINCT m.Title AS MovieTitle,
                t.Name AS TheaterName,
                d.Name AS DistrictName
FROM movies m
```

```
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
WHERE m.Length > 100
AND m.MovieCode IN (
    SELECT m2t.MovieCode
    FROM movies2theaters m2t
    JOIN theaters2districts t2d ON m2t.TheaterCode = t2d.TheaterCode
    GROUP BY m2t.MovieCode
    HAVING COUNT(DISTINCT t2d.DistrictCode) > 1
);
```

Execution Screenshot:



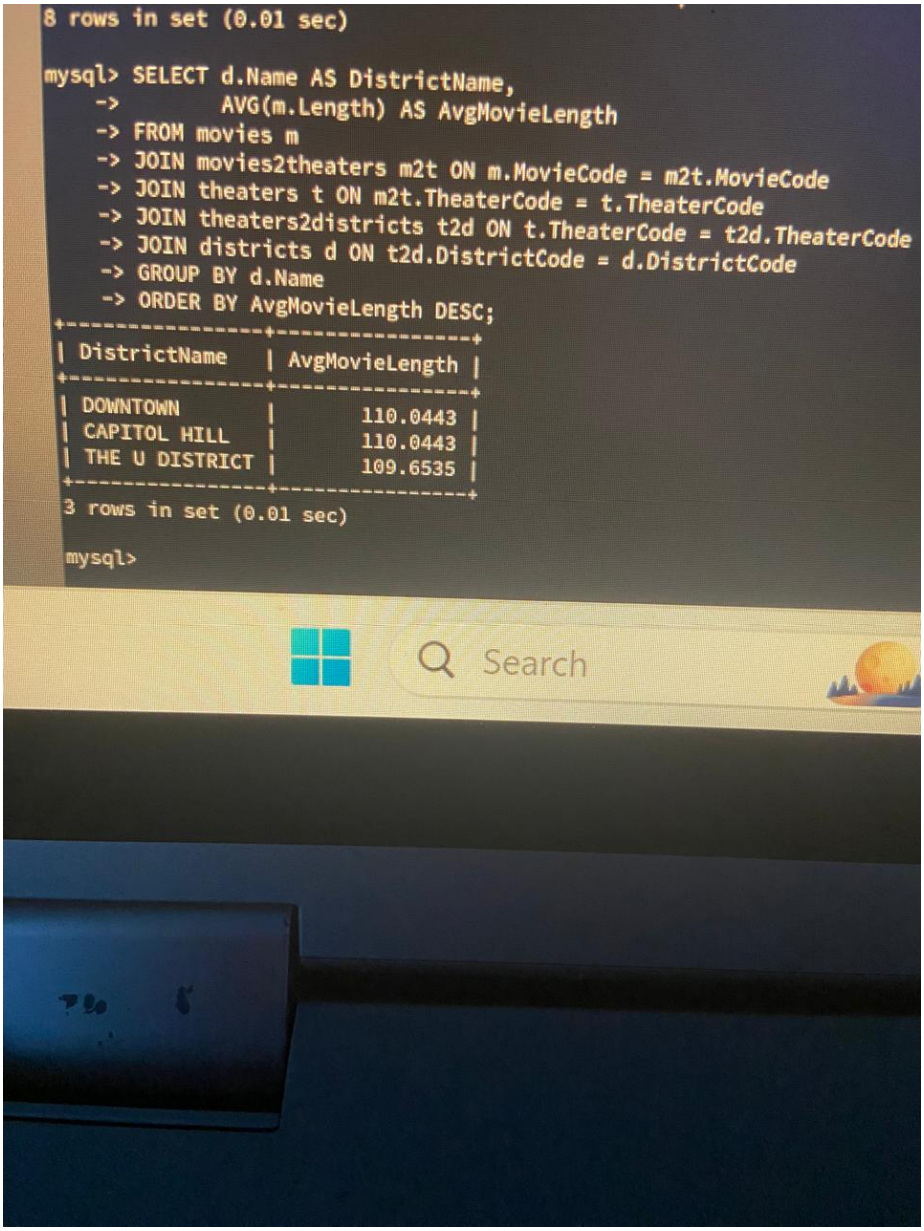
10 Question 9: Average Movie Length Per District

SQL Query:

```
SELECT d.Name AS DistrictName, AVG(m.Length) AS AvgMovieLength
```

```
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
GROUP BY d.Name
ORDER BY AvgMovieLength DESC;
```

Execution Screenshot:

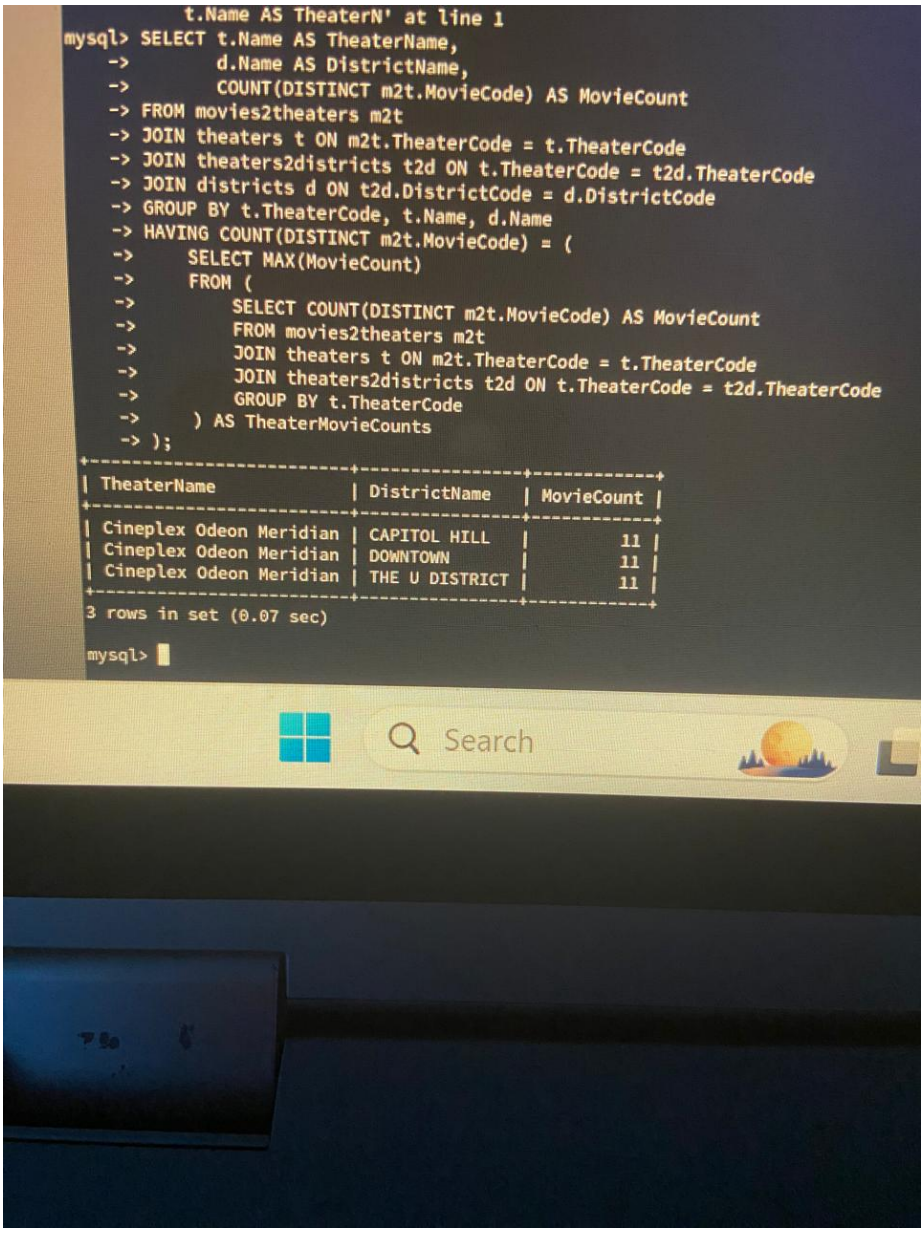


11 Question 10: Theaters Playing Maximum Distinct Movies

SQL Query:

```
SELECT t.Name AS TheaterName, COUNT(DISTINCT m2t.MovieCode) AS MovieCount
FROM movies2theaters m2t
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
GROUP BY t.Name, d.Name
HAVING COUNT(DISTINCT m2t.MovieCode) = (SELECT MAX(MovieCount) FROM (
    SELECT COUNT(DISTINCT m2t.MovieCode) AS MovieCount
    FROM movies2theaters m2t
    JOIN theaters2districts t2d ON m2t.TheaterCode = t2d.TheaterCode
    GROUP BY t2d.TheaterCode) AS MaxCounts);
```

Execution Screenshot:



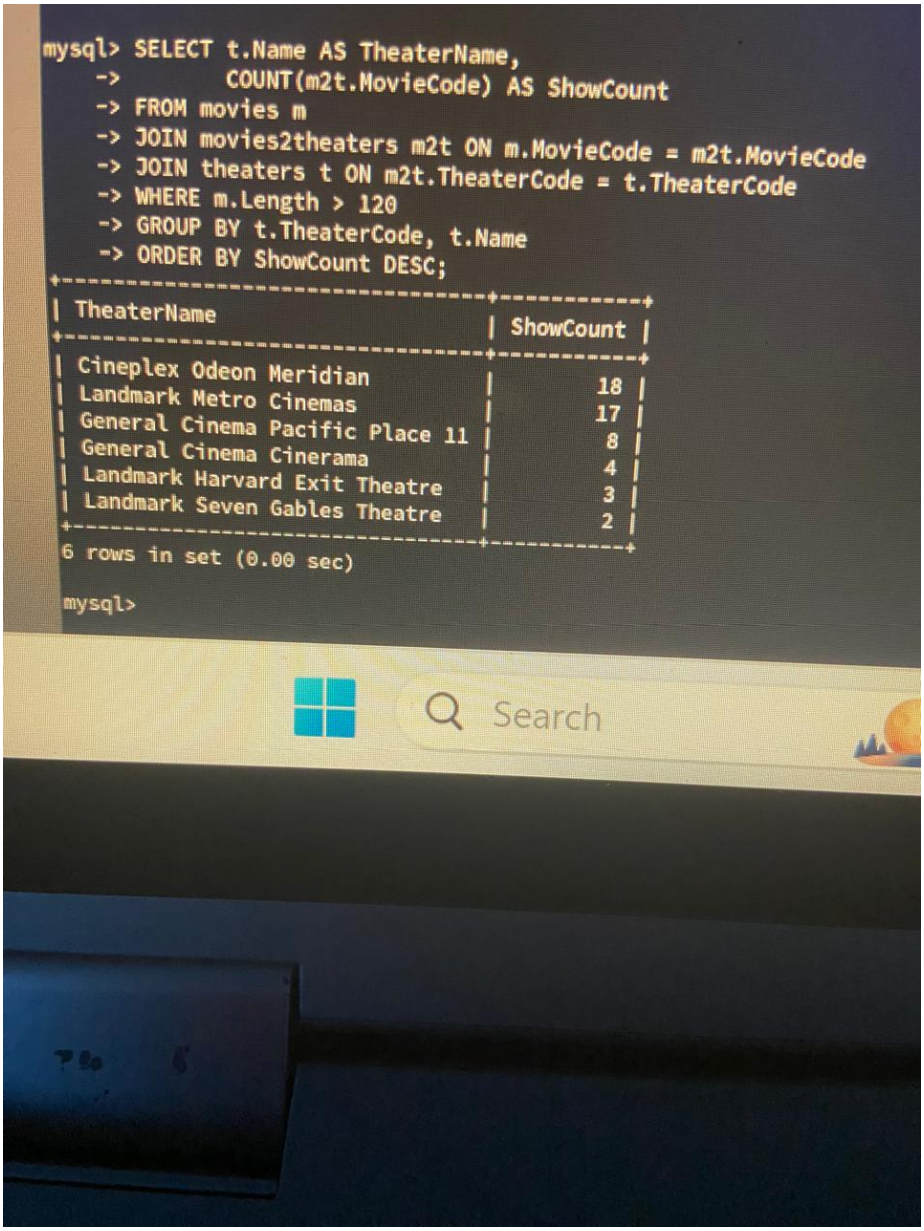
12 Question 11: Theaters Playing Movies Over 120 Minutes

SQL Query:

```
SELECT t.Name AS TheaterName, COUNT(m2t.MovieCode) AS ShowCount
```

```
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
WHERE m.Length > 120
GROUP BY t.Name
ORDER BY ShowCount DESC;
```

Execution Screenshot:

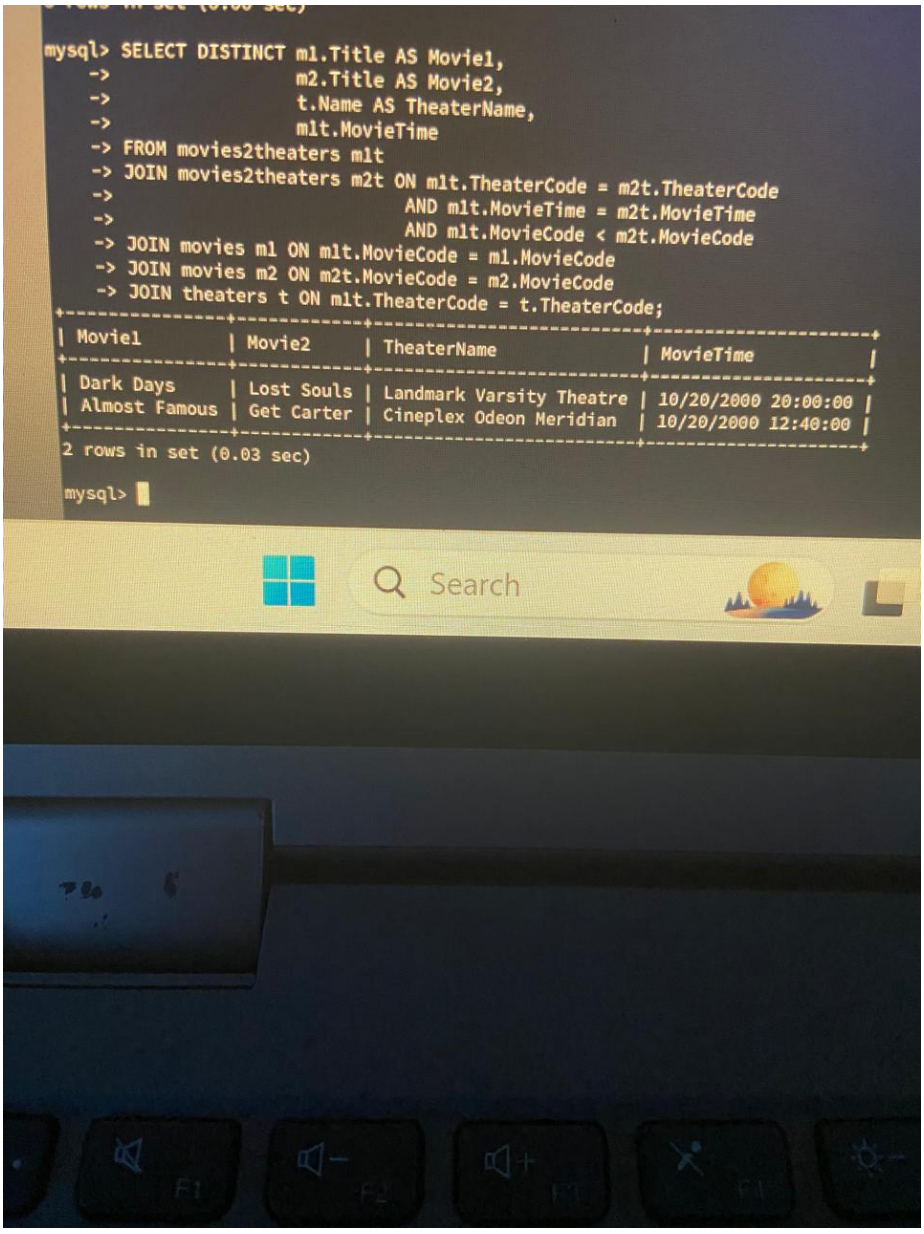


13 Question 12: Movies Played at the Same Time

SQL Query:

```
SELECT DISTINCT m1.Title AS Movie1, m2.Title AS Movie2, t.Name AS TheaterName,
m1t.MovieTime
FROM movies2theaters m1t
JOIN movies2theaters m2t ON m1t.TheaterCode = m2t.TheaterCode
                         AND m1t.MovieTime = m2t.MovieTime
                         AND m1t.MovieCode < m2t.MovieCode
JOIN movies m1 ON m1t.MovieCode = m1.MovieCode
JOIN movies m2 ON m2t.MovieCode = m2.MovieCode
JOIN theaters t ON m1t.TheaterCode = t.TheaterCode;
```

Execution Screenshot:



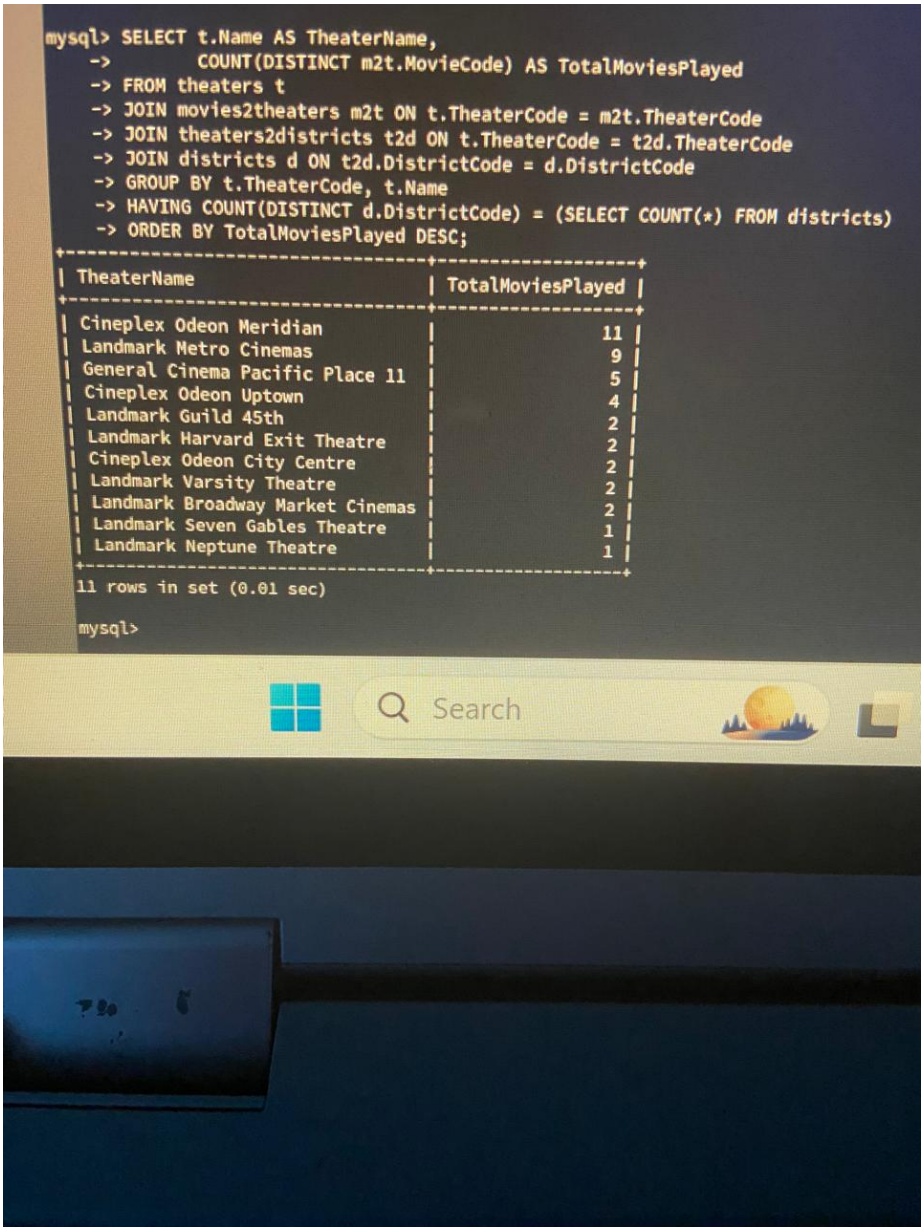
14 Bonus Question 13: Theaters That Play in Every District

SQL Query:

```
SELECT t.Name AS TheaterName, COUNT(DISTINCT m2t.MovieCode) AS TotalMoviesPlayed
```

```
FROM theaters t
JOIN movies2theaters m2t ON t.TheaterCode = m2t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
GROUP BY t.TheaterCode, t.Name
HAVING COUNT(DISTINCT d.DistrictCode) = (SELECT COUNT(*) FROM districts)
ORDER BY TotalMoviesPlayed DESC;
```

Execution Screenshot:

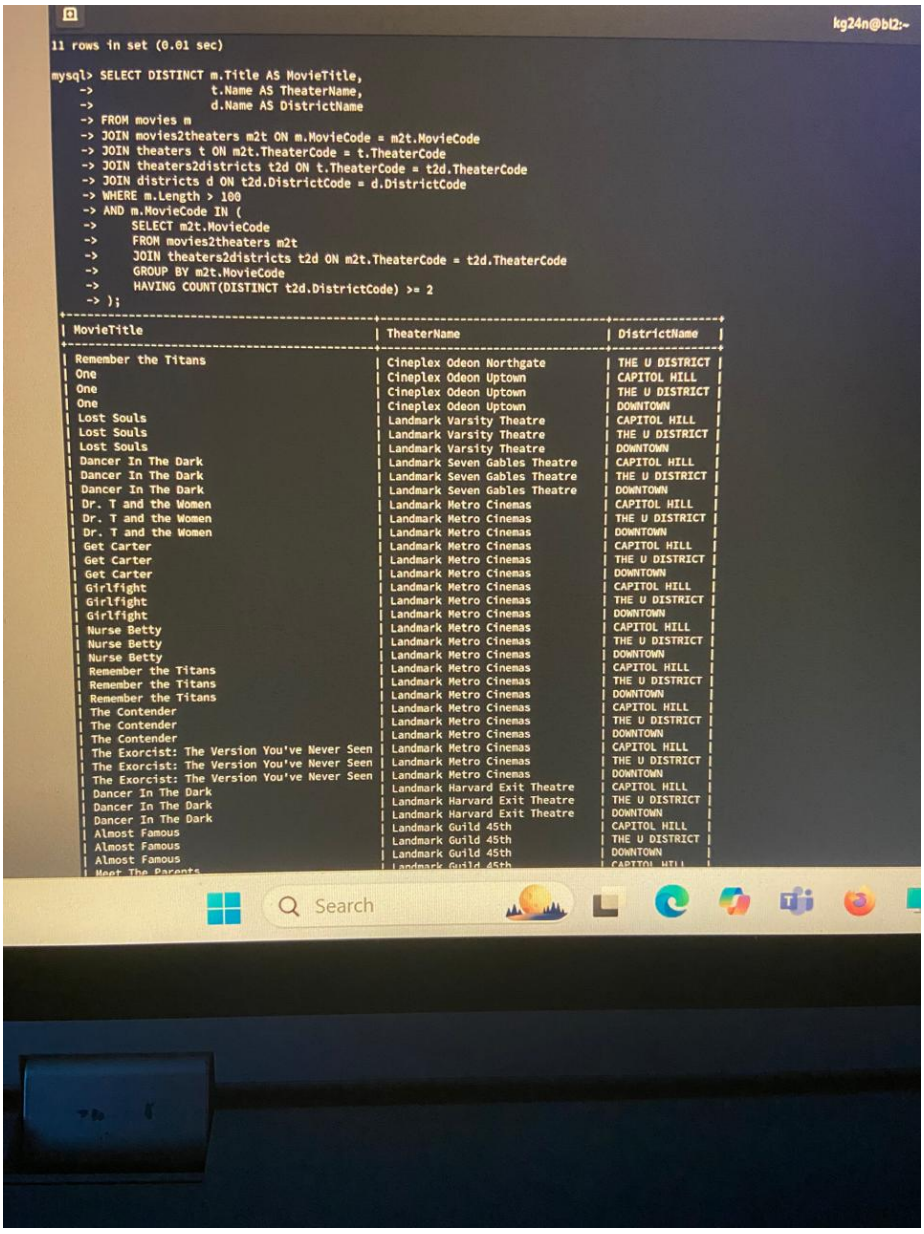


15 Bonus Question 14: Movies in Multiple Districts and Length greater than 100 Minutes

SQL Query:

```
SELECT DISTINCT m.Title AS MovieTitle, t.Name AS TheaterName, d.Name AS DistrictName
FROM movies m
JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
JOIN districts d ON t2d.DistrictCode = d.DistrictCode
WHERE m.Length > 100
AND m.MovieCode IN (
    SELECT m2t.MovieCode
    FROM movies2theaters m2t
    JOIN theaters2districts t2d ON m2t.TheaterCode = t2d.TheaterCode
    GROUP BY m2t.MovieCode
    HAVING COUNT(DISTINCT t2d.DistrictCode) > 1
);
```

Execution Screenshot:



```
kg24n@bl2:~

11 rows in set (0.01 sec)

mysql> SELECT DISTINCT m.Title AS MovieTitle,
    ->                 t.Name AS TheaterName,
    ->                 d.Name AS DistrictName
    -> FROM movies m
    -> JOIN movies2theaters m2t ON m.MovieCode = m2t.MovieCode
    -> JOIN theaters t ON m2t.TheaterCode = t.TheaterCode
    -> JOIN theaters2districts t2d ON t.TheaterCode = t2d.TheaterCode
    -> JOIN districts d ON t2d.DistrictCode = d.DistrictCode
    -> WHERE m.Length > 100
    -> AND m.MovieCode IN (
    ->     SELECT m2t.MovieCode
    ->     FROM movies2theaters m2t
    ->     JOIN theaters2districts t2d ON m2t.TheaterCode = t2d.TheaterCode
    ->     GROUP BY m2t.MovieCode
    ->     HAVING COUNT(DISTINCT t2d.DistrictCode) >= 2
    -> );
+-----------------------------------------+-----------------------------+--------------+
| MovieTitle                              | TheaterName                 | DistrictName |
+-----------------------------------------+-----------------------------+--------------+
| Remember the Titans                     | Cineplex Odeon Northgate    | THE U DISTRICT |
| One                                     | Cineplex Odeon Uptown       | CAPITOL HILL |
| One                                     | Cineplex Odeon Uptown       | THE U DISTRICT |
| One                                     | Cineplex Odeon Uptown       | DOWNTOWN     |
| Lost Souls                              | Landmark Varsity Theatre    | CAPITOL HILL |
| Lost Souls                              | Landmark Varsity Theatre    | THE U DISTRICT |
| Lost Souls                              | Landmark Varsity Theatre    | DOWNTOWN     |
| Dancer In The Dark                      | Landmark Seven Gables Theatre | CAPITOL HILL |
| Dancer In The Dark                      | Landmark Seven Gables Theatre | THE U DISTRICT |
| Dancer In The Dark                      | Landmark Seven Gables Theatre | DOWNTOWN     |
| Dr. T and the Women                     | Landmark Metro Cinemas      | CAPITOL HILL |
| Dr. T and the Women                     | Landmark Metro Cinemas      | THE U DISTRICT |
| Dr. T and the Women                     | Landmark Metro Cinemas      | DOWNTOWN     |
| Get Carter                              | Landmark Metro Cinemas      | CAPITOL HILL |
| Get Carter                              | Landmark Metro Cinemas      | THE U DISTRICT |
| Get Carter                              | Landmark Metro Cinemas      | DOWNTOWN     |
| Girlfight                               | Landmark Metro Cinemas      | CAPITOL HILL |
| Girlfight                               | Landmark Metro Cinemas      | THE U DISTRICT |
| Girlfight                               | Landmark Metro Cinemas      | DOWNTOWN     |
| Nurse Betty                             | Landmark Metro Cinemas      | CAPITOL HILL |
| Nurse Betty                             | Landmark Metro Cinemas      | THE U DISTRICT |
| Nurse Betty                             | Landmark Metro Cinemas      | DOWNTOWN     |
| Remember the Titans                     | Landmark Metro Cinemas      | CAPITOL HILL |
| Remember the Titans                     | Landmark Metro Cinemas      | THE U DISTRICT |
| Remember the Titans                     | Landmark Metro Cinemas      | DOWNTOWN     |
| The Contender                           | Landmark Metro Cinemas      | CAPITOL HILL |
| The Contender                           | Landmark Metro Cinemas      | THE U DISTRICT |
| The Contender                           | Landmark Metro Cinemas      | DOWNTOWN     |
| The Exorcist: The Version You've Never Seen | Landmark Metro Cinemas  | CAPITOL HILL |
| The Exorcist: The Version You've Never Seen | Landmark Metro Cinemas  | THE U DISTRICT |
| The Exorcist: The Version You've Never Seen | Landmark Metro Cinemas  | DOWNTOWN     |
| Dancer In The Dark                      | Landmark Harvard Exit Theatre | CAPITOL HILL |
| Dancer In The Dark                      | Landmark Harvard Exit Theatre | THE U DISTRICT |
| Dancer In The Dark                      | Landmark Harvard Exit Theatre | DOWNTOWN     |
| Almost Famous                           | Landmark Guild 45th         | CAPITOL HILL |
| Almost Famous                           | Landmark Guild 45th         | THE U DISTRICT |
| Almost Famous                           | Landmark Guild 45th         | DOWNTOWN     |
| Meet The Parents                        | Landmark Guild 45th         | CAPITOL HILL |
```