–TABLE DDL COMMANDS–

CREATE TABLE User(UserId INT Primary Key,
Username VARCHAR(255) NOT NULL,
Email VARCHAR(255) NOT NULL,
Password VARCHAR(255) NOT NULL);

CREATE TABLE Developer (DeveloperID INT Primary Key, Name VARCHAR(255),
Country VARCHAR(255));

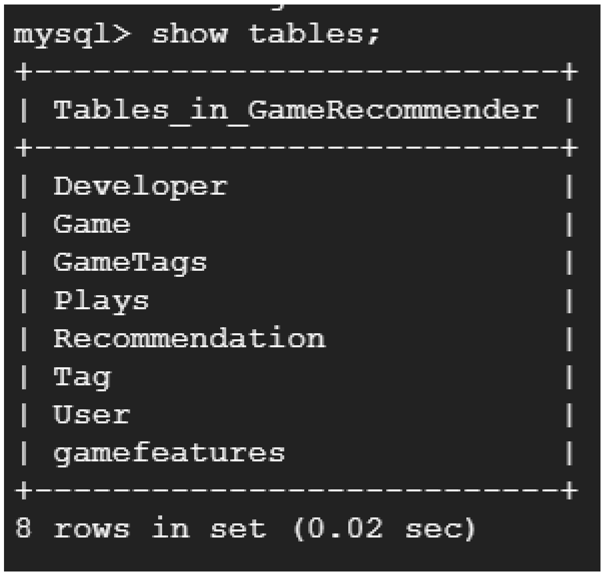
CREATE TABLE Game(GameID INT Primary Key, Title VARCHAR(255) NOT NULL,
ReleaseDate VARCHAR(255),
Price FLOAT,
DeveloperID INT,
Foreign Key (DeveloperID) References Developer(DeveloperID));

CREATE TABLE Plays (UserID INT, GameID INT,
Primary Key (UserID, GameID),
Foreign Key (UserID) References User(UserID),
Foreign Key (GameID) References Game(GameID));

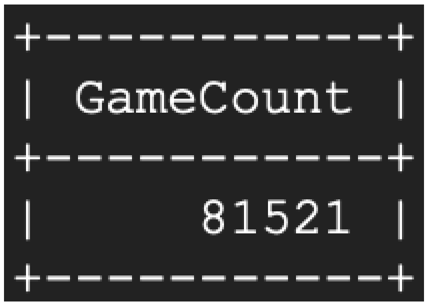
CREATE TABLE Tag(TagID INT Primary Key,
TagName VARCHAR(255) NOT NULL);

CREATE TABLE Recommendation(UserID INT, GameID INT, Rating INT, RecommendDate
VARCHAR(255),
Primary Key (UserID, GameID),
Foreign Key (UserID) References User(UserID), Foreign Key (GameID) References
Game(GameID));

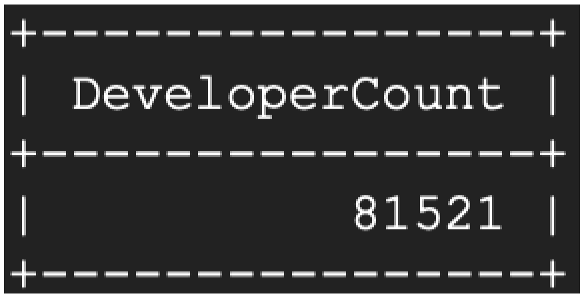
CREATE TABLE GameTags (GameID INT, TagID INT,
Primary Key (GameID, TagID),
Foreign Key (GameID) References Game(GameID),
Foreign Key (TagID) References Tag(TagID));



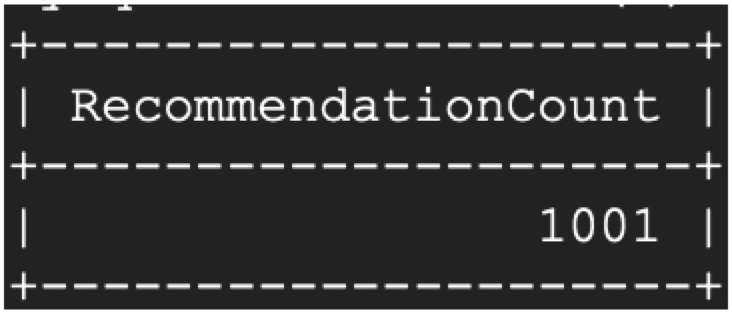
```
mysql> show tables;
+---------------------------+
| Tables_in_GameRecommender |
+---------------------------+
| Developer                 |
| Game                      |
| GameTags                  |
| Plays                     |
| Recommendation            |
| Tag                       |
| User                      |
| gamefeatures              |
+---------------------------+
8 rows in set (0.02 sec)
```



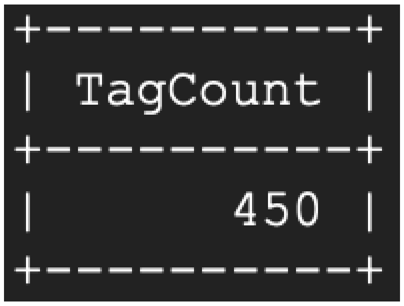
```
+-----------+
| GameCount |
+-----------+
|     81521 |
+-----------+
```



```
+----------------+
| DeveloperCount |
+----------------+
|          81521 |
+----------------+
```



```
+---------------------+
| RecommendationCount |
+---------------------+
|                1001 |
+---------------------+
```

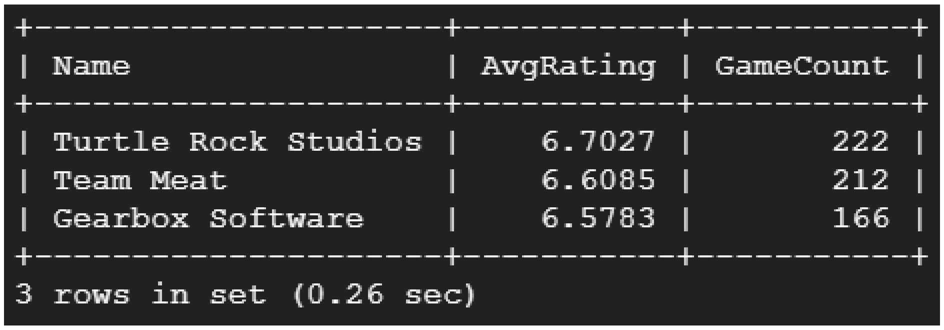


```
+----------+
| TagCount |
+----------+
|      450 |
+----------+
```

–QUERIES–

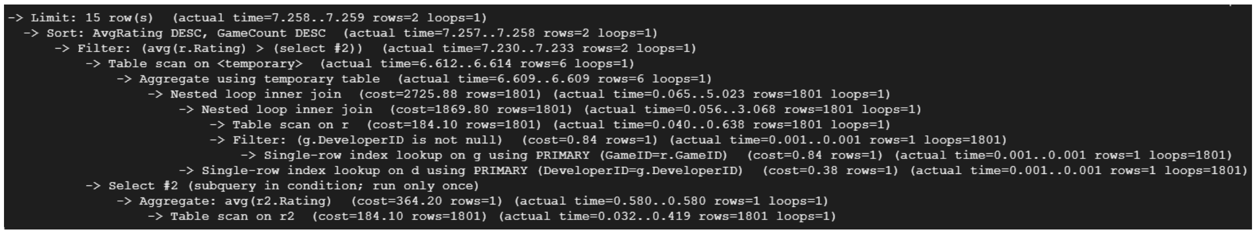
1) **Finding Developer/Developer Teams that make above average games**

```
SELECT d.Name, AVG(r.Rating) as AvgRating, COUNT(g.GameID) as GameCount
FROM Developer d
JOIN Game g ON d.DeveloperID = g.DeveloperID
JOIN Recommendation r ON g.GameID = r.GameID
GROUP BY d.DeveloperID
HAVING AVG(r.Rating) > (
   SELECT AVG(r2.Rating)
   FROM Recommendation r2
)
ORDER BY AvgRating DESC, GameCount DESC
LIMIT 15;
```



```
+---------------------+-----------+-----------+
| Name                | AvgRating | GameCount |
+---------------------+-----------+-----------+
| Turtle Rock Studios |    6.7027 |       222 |
| Team Meat           |    6.6085 |       212 |
| Gearbox Software    |    6.5783 |       166 |
+---------------------+-----------+-----------+
3 rows in set (0.26 sec)
```

Before Indexing:



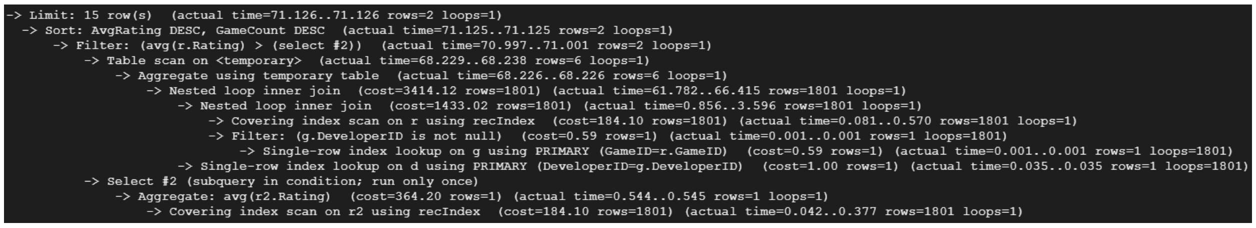
```
-> Limit: 15 row(s)  (actual time=7.258..7.259 rows=2 loops=1)
  -> Sort: AvgRating DESC, GameCount DESC  (actual time=7.257..7.258 rows=2 loops=1)
      -> Filter: (avg(r.Rating) > (select #2))  (actual time=7.230..7.233 rows=2 loops=1)
          -> Table scan on <temporary>  (actual time=6.612..6.614 rows=6 loops=1)
              -> Aggregate using temporary table  (actual time=6.609..6.609 rows=6 loops=1)
                  -> Nested loop inner join  (cost=2725.88 rows=1801) (actual time=0.065..5.023 rows=1801 loops=1)
                      -> Nested loop inner join  (cost=1869.80 rows=1801) (actual time=0.056..3.068 rows=1801 loops=1)
                          -> Table scan on r  (cost=184.10 rows=1801) (actual time=0.040..0.638 rows=1801 loops=1)
                          -> Filter: (g.DeveloperID is not null)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                              -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                      -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=0.38 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
          -> Select #2 (subquery in condition; run only once)
              -> Aggregate: avg(r2.Rating)  (cost=364.20 rows=1) (actual time=0.580..0.580 rows=1 loops=1)
                  -> Table scan on r2  (cost=184.10 rows=1801) (actual time=0.032..0.419 rows=1801 loops=1)
```

Cost – 2725

—

First Index:

CREATE INDEX recIndex ON Recommendation (Rating);



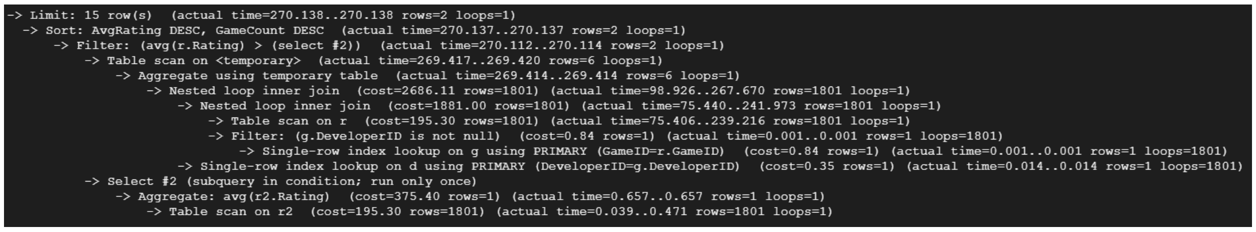
```
-> Limit: 15 row(s)  (actual time=71.126..71.126 rows=2 loops=1)
  -> Sort: AvgRating DESC, GameCount DESC  (actual time=71.125..71.125 rows=2 loops=1)
      -> Filter: (avg(r.Rating) > (select #2))  (actual time=70.997..71.001 rows=2 loops=1)
          -> Table scan on <temporary>  (actual time=68.229..68.238 rows=6 loops=1)
              -> Aggregate using temporary table  (actual time=68.226..68.226 rows=6 loops=1)
                  -> Nested loop inner join  (cost=3414.12 rows=1801) (actual time=61.782..66.415 rows=1801 loops=1)
                      -> Nested loop inner join  (cost=1433.02 rows=1801) (actual time=0.856..3.596 rows=1801 loops=1)
                          -> Covering index scan on r using recIndex  (cost=184.10 rows=1801) (actual time=0.081..0.570 rows=1801 loops=1)
                          -> Filter: (g.DeveloperID is not null)  (cost=0.59 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                              -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.59 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                      -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=1.00 rows=1) (actual time=0.035..0.035 rows=1 loops=1801)
          -> Select #2 (subquery in condition; run only once)
              -> Aggregate: avg(r2.Rating)  (cost=364.20 rows=1) (actual time=0.544..0.545 rows=1 loops=1)
                  -> Covering index scan on r2 using recIndex  (cost=184.10 rows=1801) (actual time=0.042..0.377 rows=1801 loops=1)
```

Cost – 3414

—

Second Index:

CREATE INDEX nameIndex ON Developer (Name);



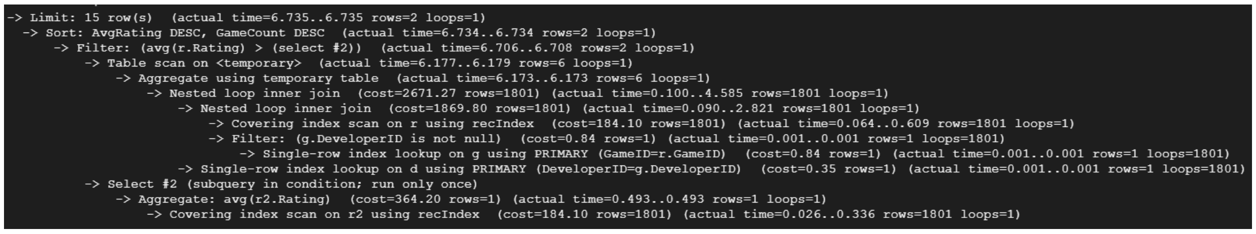
```
-> Limit: 15 row(s)  (actual time=270.138..270.138 rows=2 loops=1)
  -> Sort: AvgRating DESC, GameCount DESC  (actual time=270.137..270.137 rows=2 loops=1)
      -> Filter: (avg(r.Rating) > (select #2))  (actual time=270.112..270.114 rows=2 loops=1)
          -> Table scan on <temporary>  (actual time=269.417..269.420 rows=6 loops=1)
              -> Aggregate using temporary table  (actual time=269.414..269.414 rows=6 loops=1)
                  -> Nested loop inner join  (cost=2686.11 rows=1801) (actual time=98.926..267.670 rows=1801 loops=1)
                      -> Nested loop inner join  (cost=1881.00 rows=1801) (actual time=75.440..241.973 rows=1801 loops=1)
                          -> Table scan on r  (cost=195.30 rows=1801) (actual time=75.406..239.216 rows=1801 loops=1)
                          -> Filter: (g.DeveloperID is not null)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                              -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                      -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=0.35 rows=1) (actual time=0.014..0.014 rows=1 loops=1801)
          -> Select #2 (subquery in condition; run only once)
              -> Aggregate: avg(r2.Rating)  (cost=375.40 rows=1) (actual time=0.657..0.657 rows=1 loops=1)
                  -> Table scan on r2  (cost=195.30 rows=1801) (actual time=0.039..0.471 rows=1801 loops=1)
```

Cost – 2686

—

Third Index:

CREATE INDEX recIndex ON Recommendation (Rating);
CREATE INDEX nameIndex ON Developer (Name);



```
-> Limit: 15 row(s)  (actual time=6.735..6.735 rows=2 loops=1)
  -> Sort: AvgRating DESC, GameCount DESC  (actual time=6.734..6.734 rows=2 loops=1)
      -> Filter: (avg(r.Rating) > (select #2))  (actual time=6.706..6.708 rows=2 loops=1)
          -> Table scan on <temporary>  (actual time=6.177..6.179 rows=6 loops=1)
              -> Aggregate using temporary table  (actual time=6.173..6.173 rows=6 loops=1)
                  -> Nested loop inner join  (cost=2671.27 rows=1801) (actual time=0.100..4.585 rows=1801 loops=1)
                      -> Nested loop inner join  (cost=1869.80 rows=1801) (actual time=0.090..2.821 rows=1801 loops=1)
                          -> Covering index scan on r using recIndex  (cost=184.10 rows=1801) (actual time=0.064..0.609 rows=1801 loops=1)
                          -> Filter: (g.DeveloperID is not null)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                              -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.84 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                      -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=0.35 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
          -> Select #2 (subquery in condition; run only once)
              -> Aggregate: avg(r2.Rating)  (cost=364.20 rows=1) (actual time=0.493..0.493 rows=1 loops=1)
                  -> Covering index scan on r2 using recIndex  (cost=184.10 rows=1801) (actual time=0.026..0.336 rows=1801 loops=1)
```

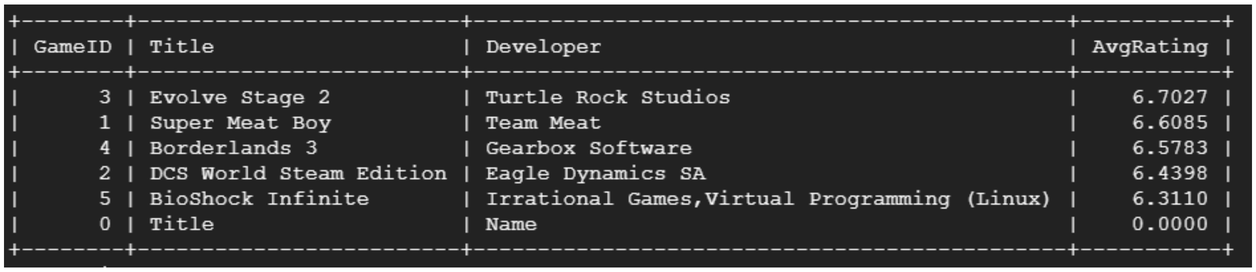
Cost – 2671

Analysis: Our chosen design was the third index, which creates an index on both the Rating column in the Recommendation table, and the Name column in the developer table. Indexing the Name column seems to be key, as it targets a column that has a lot of operations on it. However, this optimization only improved performance a little more than the default setting.

2) Find top-rated games through average rating

SELECT g.GameID, g.Title, d.Name AS Developer, AVG(r.Rating) AS AvgRating
FROM Game g

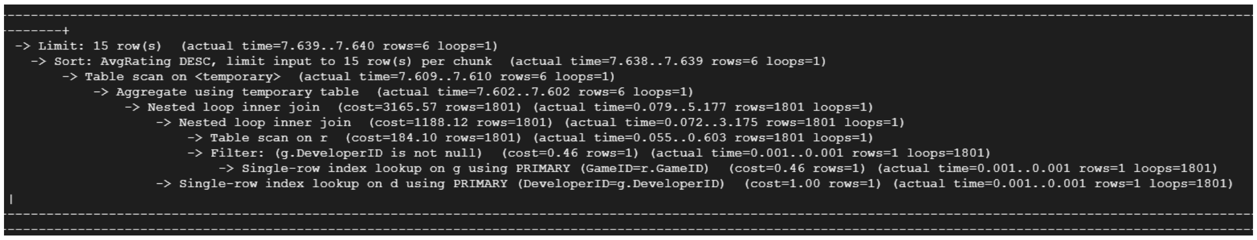
JOIN Recommendation r ON g.GameID = r.GameID
JOIN Developer d ON g.DeveloperID = d.DeveloperID
GROUP BY g.GameID, g.Title, d.Name
ORDER BY AvgRating DESC
LIMIT 15;



```
+--------+------------------------+--------------------------------------------+-----------+
| GameID | Title                  | Developer                                  | AvgRating |
+--------+------------------------+--------------------------------------------+-----------+
|      3 | Evolve Stage 2         | Turtle Rock Studios                        |    6.7027 |
|      1 | Super Meat Boy         | Team Meat                                  |    6.6085 |
|      4 | Borderlands 3          | Gearbox Software                           |    6.5783 |
|      2 | DCS World Steam Edition | Eagle Dynamics SA                         |    6.4398 |
|      5 | BioShock Infinite      | Irrational Games,Virtual Programming (Linux) |    6.3110 |
|      0 | Title                  | Name                                       |    0.0000 |
+--------+------------------------+--------------------------------------------+-----------+
```

INDEX:

NO INDEXING:

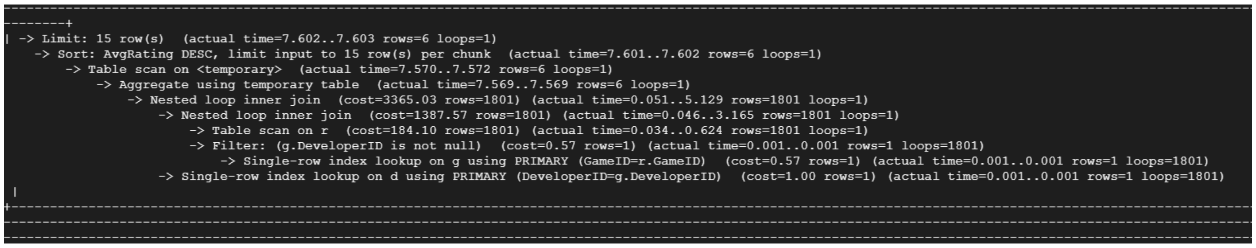


```
--------------------------------------------------------------------------------
--------+
 -> Limit: 15 row(s)  (actual time=7.639..7.640 rows=6 loops=1)
   -> Sort: AvgRating DESC, limit input to 15 row(s) per chunk  (actual time=7.638..7.639 rows=6 loops=1)
       -> Table scan on <temporary>  (actual time=7.609..7.610 rows=6 loops=1)
           -> Aggregate using temporary table  (actual time=7.602..7.602 rows=6 loops=1)
               -> Nested loop inner join  (cost=3165.57 rows=1801) (actual time=0.079..5.177 rows=1801 loops=1)
                   -> Nested loop inner join  (cost=1188.12 rows=1801) (actual time=0.072..3.175 rows=1801 loops=1)
                       -> Table scan on r  (cost=184.10 rows=1801) (actual time=0.055..0.603 rows=1801 loops=1)
                       -> Filter: (g.DeveloperID is not null)  (cost=0.46 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                           -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.46 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                   -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=1.00 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
|
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

Cost = 3165.57

—

First Index:
CREATE INDEX idx_Title_Game ON Game (Title);

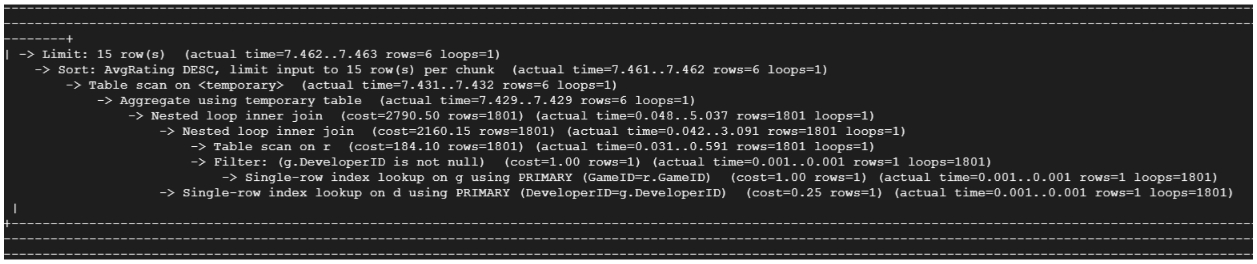


```
--------------------------------------------------------------------------------
--------+
| -> Limit: 15 row(s)  (actual time=7.602..7.603 rows=6 loops=1)
    -> Sort: AvgRating DESC, limit input to 15 row(s) per chunk  (actual time=7.601..7.602 rows=6 loops=1)
        -> Table scan on <temporary>  (actual time=7.570..7.572 rows=6 loops=1)
            -> Aggregate using temporary table  (actual time=7.569..7.569 rows=6 loops=1)
                -> Nested loop inner join  (cost=3365.03 rows=1801) (actual time=0.051..5.129 rows=1801 loops=1)
                    -> Nested loop inner join  (cost=1387.57 rows=1801) (actual time=0.046..3.165 rows=1801 loops=1)
                        -> Table scan on r  (cost=184.10 rows=1801) (actual time=0.034..0.624 rows=1801 loops=1)
                        -> Filter: (g.DeveloperID is not null)  (cost=0.57 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                            -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.57 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                    -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=1.00 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
 |
+-------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

Cost = 3365.03

—

Second Index:
CREATE INDEX idx_Name_Developer ON Developer (Name);

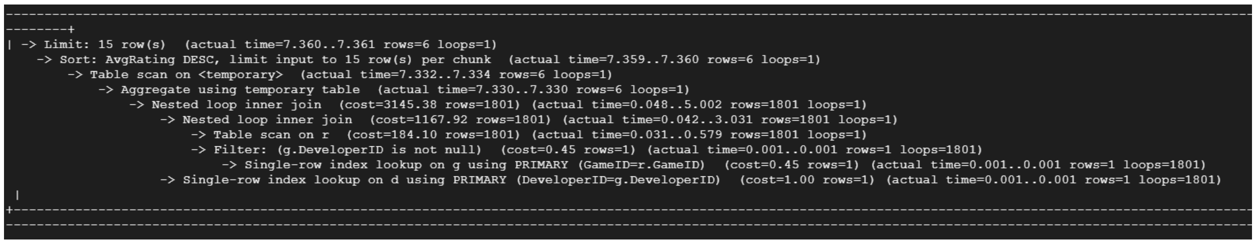


```
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------+
| -> Limit: 15 row(s)  (actual time=7.462..7.463 rows=6 loops=1)
    -> Sort: AvgRating DESC, limit input to 15 row(s) per chunk  (actual time=7.461..7.462 rows=6 loops=1)
        -> Table scan on <temporary>  (actual time=7.431..7.432 rows=6 loops=1)
            -> Aggregate using temporary table  (actual time=7.429..7.429 rows=6 loops=1)
                -> Nested loop inner join  (cost=2790.50 rows=1801) (actual time=0.048..5.037 rows=1801 loops=1)
                    -> Nested loop inner join  (cost=2160.15 rows=1801) (actual time=0.042..3.091 rows=1801 loops=1)
                        -> Table scan on r  (cost=184.10 rows=1801) (actual time=0.031..0.591 rows=1801 loops=1)
                        -> Filter: (g.DeveloperID is not null)  (cost=1.00 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                            -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=1.00 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                    -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=0.25 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
 |
+-------------------------------------------------------------------------------
--------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

Cost = 2790.50

—

Third Index:
CREATE INDEX idx_Title_Game ON Game (Title);
CREATE INDEX idx_Name_Developer ON Developer (Name);



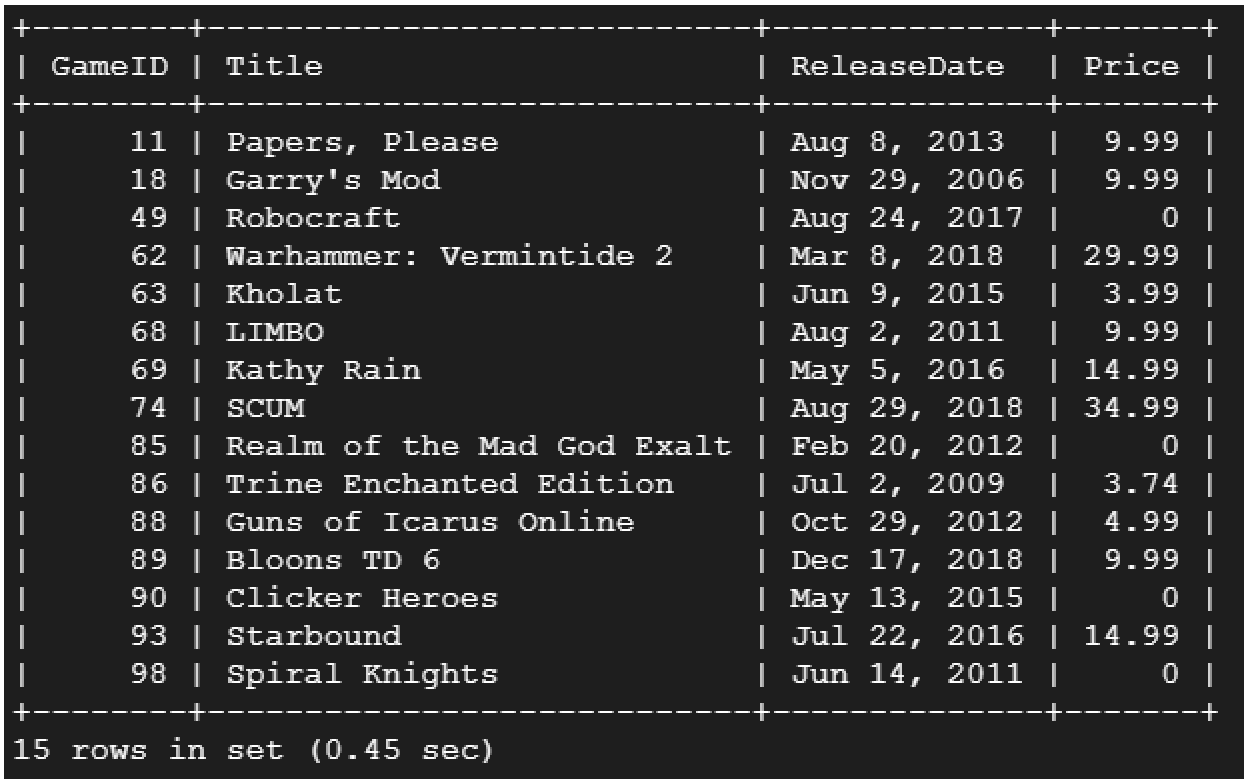
```
--------------------------------------------------------------------------------
--------+
| -> Limit: 15 row(s)  (actual time=7.360..7.361 rows=6 loops=1)
    -> Sort: AvgRating DESC, limit input to 15 row(s) per chunk  (actual time=7.359..7.360 rows=6 loops=1)
        -> Table scan on <temporary>  (actual time=7.332..7.334 rows=6 loops=1)
            -> Aggregate using temporary table  (actual time=7.330..7.330 rows=6 loops=1)
                -> Nested loop inner join  (cost=3145.38 rows=1801) (actual time=0.048..5.002 rows=1801 loops=1)
                    -> Nested loop inner join  (cost=1167.92 rows=1801) (actual time=0.042..3.031 rows=1801 loops=1)
                        -> Table scan on r  (cost=184.10 rows=1801) (actual time=0.031..0.579 rows=1801 loops=1)
                        -> Filter: (g.DeveloperID is not null)  (cost=0.45 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                            -> Single-row index lookup on g using PRIMARY (GameID=r.GameID)  (cost=0.45 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
                    -> Single-row index lookup on d using PRIMARY (DeveloperID=g.DeveloperID)  (cost=1.00 rows=1) (actual time=0.001..0.001 rows=1 loops=1801)
 |
+-------------------------------------------------------------------------------
--------------------------------------------------------------------------------
```

Cost = 3145.38

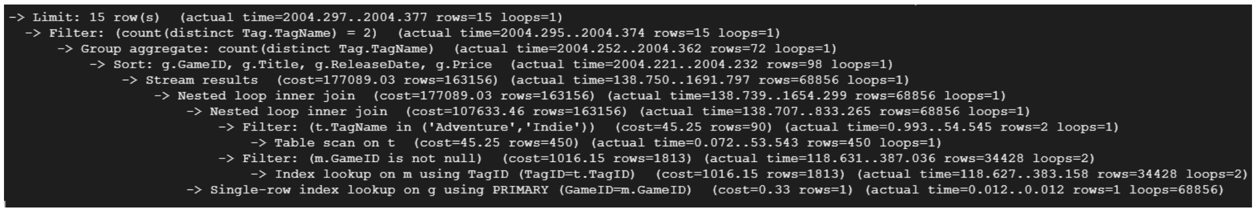
ANALYSIS**:** The index design that we have decided to go for is the index for Developer Name. The reason why the `Developer.Name` column was effective is that it optimized the operations the query performs most intensively through its grouping. Specifically, by the developer name and potentially improving the efficiency of the join operation.

3) Find a specific game using a specific tag for both Adventure and Indie

SELECT g.GameID, g.Title, g.ReleaseDate, g.Price
FROM Game g JOIN GameTags m ON (g. GameID = m.GameID)
JOIN Tag t ON (m.TagID = t.TagID)
WHERE t.TagName IN ('Adventure', 'Indie')
GROUP BY g.GameID, g.Title, g.ReleaseDate, g.Price
HAVING COUNT(DISTINCT t.TagName) = 2
LIMIT 15;



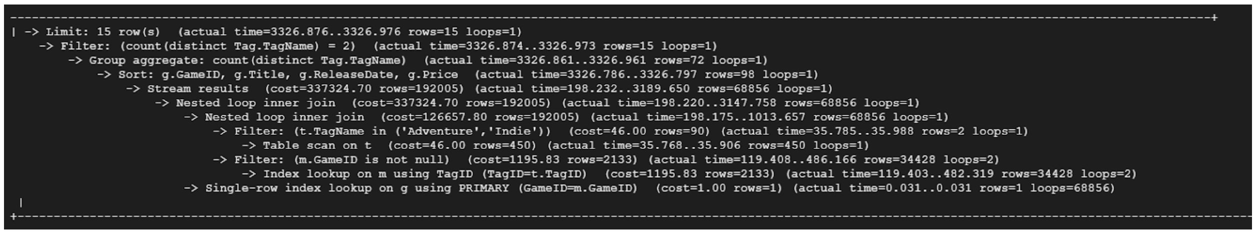
```
+--------+----------------------------+--------------+-------+
| GameID | Title                      | ReleaseDate  | Price |
+--------+----------------------------+--------------+-------+
|     11 | Papers, Please             | Aug 8, 2013  |  9.99 |
|     18 | Garry's Mod                | Nov 29, 2006 |  9.99 |
|     49 | Robocraft                  | Aug 24, 2017 |     0 |
|     62 | Warhammer: Vermintide 2    | Mar 8, 2018  | 29.99 |
|     63 | Kholat                     | Jun 9, 2015  |  3.99 |
|     68 | LIMBO                      | Aug 2, 2011  |  9.99 |
|     69 | Kathy Rain                 | May 5, 2016  | 14.99 |
|     74 | SCUM                       | Aug 29, 2018 | 34.99 |
|     85 | Realm of the Mad God Exalt | Feb 20, 2012 |     0 |
|     86 | Trine Enchanted Edition    | Jul 2, 2009  |  3.74 |
|     88 | Guns of Icarus Online      | Oct 29, 2012 |  4.99 |
|     89 | Bloons TD 6                | Dec 17, 2018 |  9.99 |
|     90 | Clicker Heroes             | May 13, 2015 |     0 |
|     93 | Starbound                  | Jul 22, 2016 | 14.99 |
|     98 | Spiral Knights             | Jun 14, 2011 |     0 |
+--------+----------------------------+--------------+-------+
15 rows in set (0.45 sec)
```



```
-> Limit: 15 row(s)  (actual time=2004.297..2004.377 rows=15 loops=1)
  -> Filter: (count(distinct Tag.TagName) = 2)  (actual time=2004.295..2004.374 rows=15 loops=1)
      -> Group aggregate: count(distinct Tag.TagName)  (actual time=2004.252..2004.362 rows=72 loops=1)
          -> Sort: g.GameID, g.Title, g.ReleaseDate, g.Price  (actual time=2004.221..2004.232 rows=98 loops=1)
              -> Stream results  (cost=177089.03 rows=163156) (actual time=138.750..1691.797 rows=68856 loops=1)
                  -> Nested loop inner join  (cost=177089.03 rows=163156) (actual time=138.739..1654.299 rows=68856 loops=1)
                      -> Nested loop inner join  (cost=107633.46 rows=163156) (actual time=138.707..833.265 rows=68856 loops=1)
                          -> Filter: (t.TagName in ('Adventure','Indie'))  (cost=45.25 rows=90) (actual time=0.993..54.545 rows=2 loops=1)
                              -> Table scan on t  (cost=45.25 rows=450) (actual time=0.072..53.543 rows=450 loops=1)
                          -> Filter: (m.GameID is not null)  (cost=1016.15 rows=1813) (actual time=118.631..387.036 rows=34428 loops=2)
                              -> Index lookup on m using TagID (TagID=t.TagID)  (cost=1016.15 rows=1813) (actual time=118.627..383.158 rows=34428 loops=2)
                      -> Single-row index lookup on g using PRIMARY (GameID=m.GameID)  (cost=0.33 rows=1) (actual time=0.012..0.012 rows=1 loops=68856)
```

INDEX:

NO INDEXING:



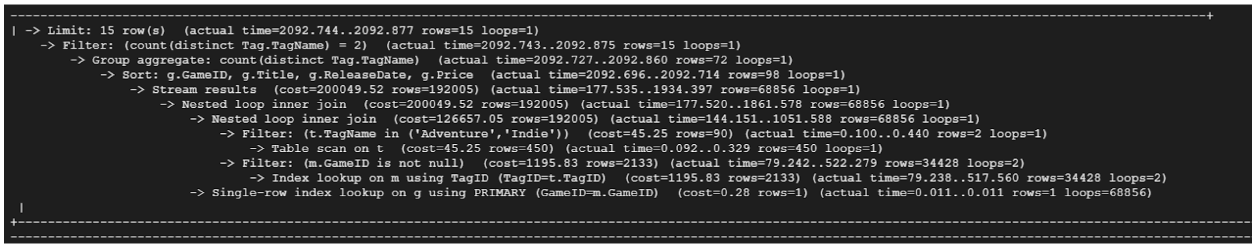
```
--------------------------------------------------------------------------------------------------------------------------------------------------------+
| -> Limit: 15 row(s)  (actual time=3326.876..3326.976 rows=15 loops=1)
    -> Filter: (count(distinct Tag.TagName) = 2)  (actual time=3326.874..3326.973 rows=15 loops=1)
        -> Group aggregate: count(distinct Tag.TagName)  (actual time=3326.861..3326.961 rows=72 loops=1)
            -> Sort: g.GameID, g.Title, g.ReleaseDate, g.Price  (actual time=3326.786..3326.797 rows=98 loops=1)
                -> Stream results  (cost=337324.70 rows=192005) (actual time=198.232..3189.650 rows=68856 loops=1)
                    -> Nested loop inner join  (cost=337324.70 rows=192005) (actual time=198.220..3147.758 rows=68856 loops=1)
                        -> Nested loop inner join  (cost=126657.80 rows=192005) (actual time=198.175..1013.657 rows=68856 loops=1)
                            -> Filter: (t.TagName in ('Adventure','Indie'))  (cost=46.00 rows=90) (actual time=35.785..35.988 rows=2 loops=1)
                                -> Table scan on t  (cost=46.00 rows=450) (actual time=35.768..35.906 rows=450 loops=1)
                            -> Filter: (m.GameID is not null)  (cost=1195.83 rows=2133) (actual time=119.408..486.166 rows=34428 loops=2)
                                -> Index lookup on m using TagID (TagID=t.TagID)  (cost=1195.83 rows=2133) (actual time=119.403..482.319 rows=34428 loops=2)
                        -> Single-row index lookup on g using PRIMARY (GameID=m.GameID)  (cost=1.00 rows=1) (actual time=0.031..0.031 rows=1 loops=68856)
 |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

Cost = 337,324.70

—

First Index:

CREATE INDEX idx_title_game ON Game (Title);



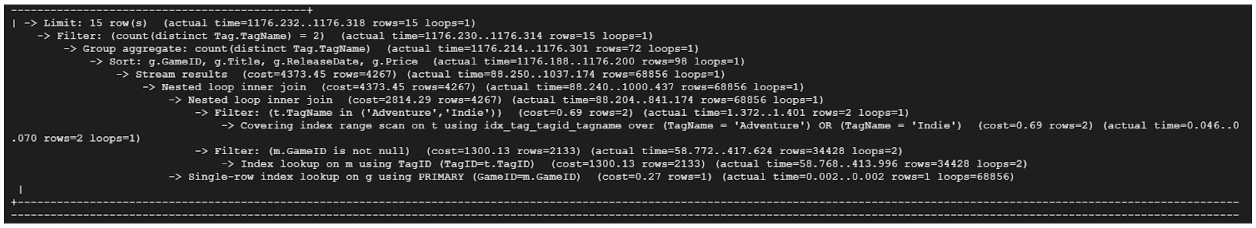
```
--------------------------------------------------------------------------------------------------------------------------------------------------------+
| -> Limit: 15 row(s)  (actual time=2092.744..2092.877 rows=15 loops=1)
    -> Filter: (count(distinct Tag.TagName) = 2)  (actual time=2092.743..2092.875 rows=15 loops=1)
        -> Group aggregate: count(distinct Tag.TagName)  (actual time=2092.727..2092.860 rows=72 loops=1)
            -> Sort: g.GameID, g.Title, g.ReleaseDate, g.Price  (actual time=2092.696..2092.714 rows=98 loops=1)
                -> Stream results  (cost=200049.52 rows=192005) (actual time=177.535..1934.397 rows=68856 loops=1)
                    -> Nested loop inner join  (cost=200049.52 rows=192005) (actual time=177.520..1861.578 rows=68856 loops=1)
                        -> Nested loop inner join  (cost=126657.05 rows=192005) (actual time=144.151..1051.588 rows=68856 loops=1)
                            -> Filter: (t.TagName in ('Adventure','Indie'))  (cost=45.25 rows=90) (actual time=0.100..0.440 rows=2 loops=1)
                                -> Table scan on t  (cost=45.25 rows=450) (actual time=0.092..0.329 rows=450 loops=1)
                            -> Filter: (m.GameID is not null)  (cost=1195.83 rows=2133) (actual time=79.242..522.279 rows=34428 loops=2)
                                -> Index lookup on m using TagID (TagID=t.TagID)  (cost=1195.83 rows=2133) (actual time=79.238..517.560 rows=34428 loops=2)
                        -> Single-row index lookup on g using PRIMARY (GameID=m.GameID)  (cost=0.28 rows=1) (actual time=0.011..0.011 rows=1 loops=68856)
 |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

Cost = 200049.52

—

Second Index:

CREATE INDEX idx_tag_tagid_tagname ON Tag (TagName);



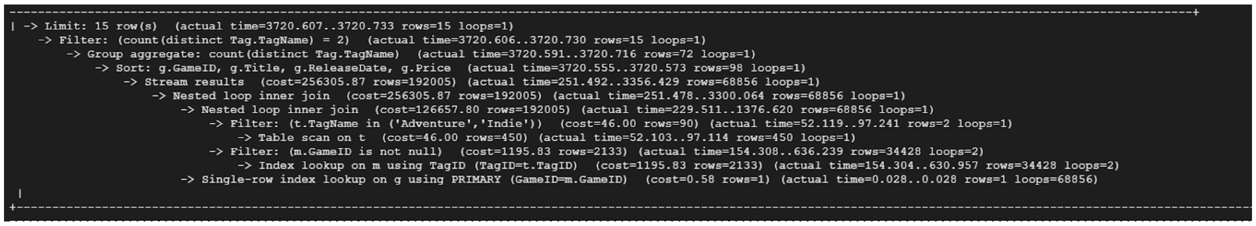
```
--------------------------------------------+
| -> Limit: 15 row(s)  (actual time=1176.232..1176.318 rows=15 loops=1)
    -> Filter: (count(distinct Tag.TagName) = 2)  (actual time=1176.230..1176.314 rows=15 loops=1)
        -> Group aggregate: count(distinct Tag.TagName)  (actual time=1176.214..1176.301 rows=72 loops=1)
            -> Sort: g.GameID, g.Title, g.ReleaseDate, g.Price  (actual time=1176.188..1176.200 rows=98 loops=1)
                -> Stream results  (cost=4373.45 rows=4267) (actual time=88.250..1037.174 rows=68856 loops=1)
                    -> Nested loop inner join  (cost=4373.45 rows=4267) (actual time=88.240..1000.437 rows=68856 loops=1)
                        -> Nested loop inner join  (cost=2814.29 rows=4267) (actual time=88.204..841.174 rows=68856 loops=1)
                            -> Filter: (t.TagName in ('Adventure','Indie'))  (cost=0.69 rows=2) (actual time=1.372..1.401 rows=2 loops=1)
                                -> Covering index range scan on t using idx_tag_tagid_tagname over (TagName = 'Adventure') OR (TagName = 'Indie')  (cost=0.69 rows=2) (actual time=0.046..0
.070 rows=2 loops=1)
                            -> Filter: (m.GameID is not null)  (cost=1300.13 rows=2133) (actual time=58.772..417.624 rows=34428 loops=2)
                                -> Index lookup on m using TagID (TagID=t.TagID)  (cost=1300.13 rows=2133) (actual time=58.768..413.996 rows=34428 loops=2)
                        -> Single-row index lookup on g using PRIMARY (GameID=m.GameID)  (cost=0.27 rows=1) (actual time=0.002..0.002 rows=1 loops=68856)
 |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------
-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

Cost = 4373.45

—

Third Index:

CREATE INDEX idx_game_composite ON Game (Title, ReleaseDate, Price);



```
--------------------------------------------------------------------------------------------------------------------------------------------------------+
| -> Limit: 15 row(s)  (actual time=3720.607..3720.733 rows=15 loops=1)
    -> Filter: (count(distinct Tag.TagName) = 2)  (actual time=3720.606..3720.730 rows=15 loops=1)
        -> Group aggregate: count(distinct Tag.TagName)  (actual time=3720.591..3720.716 rows=72 loops=1)
            -> Sort: g.GameID, g.Title, g.ReleaseDate, g.Price  (actual time=3720.555..3720.573 rows=98 loops=1)
                -> Stream results  (cost=256305.87 rows=192005) (actual time=251.492..3356.429 rows=68856 loops=1)
                    -> Nested loop inner join  (cost=256305.87 rows=192005) (actual time=251.478..3300.064 rows=68856 loops=1)
                        -> Nested loop inner join  (cost=126657.80 rows=192005) (actual time=229.511..1376.620 rows=68856 loops=1)
                            -> Filter: (t.TagName in ('Adventure','Indie'))  (cost=46.00 rows=90) (actual time=52.119..97.241 rows=2 loops=1)
                                -> Table scan on t  (cost=46.00 rows=450) (actual time=52.103..97.114 rows=450 loops=1)
                            -> Filter: (m.GameID is not null)  (cost=1195.83 rows=2133) (actual time=154.308..636.239 rows=34428 loops=2)
                                -> Index lookup on m using TagID (TagID=t.TagID)  (cost=1195.83 rows=2133) (actual time=154.304..630.957 rows=34428 loops=2)
                        -> Single-row index lookup on g using PRIMARY (GameID=m.GameID)  (cost=0.58 rows=1) (actual time=0.028..0.028 rows=1 loops=68856)
 |
+-----------------------------------------------------------------------------------------------------------------------------------------------------------
```

COST = 256305.87

ANALYSIS: The index design that we have decided to go for is the index for Tag Name. We can say for a fact that using the TagName index has definitely improved the cost by a large margin.

The reason why the `TagName` column was super effective is that it solely optimized the operations that the query specifically demands for. The TagName column alone has a lot of values inside so to have an index that only takes a look at that column and its IDs has majorly saved both money and time.

Unfortunately the following query is DYSFUNCTIONAL (or maybe the data in our tables is wrong)

4) Recommend Game based on games played

```
SELECT g.Title, g.Price, AVG(r.Rating) as AvgRating, COUNT(r.GameID) as
RecommendationCount
FROM Game g
JOIN Recommendation r ON g.GameID = r.GameID
JOIN GameTags gt ON g.GameID = gt.GameID
JOIN Tag t ON gt.TagID = t.TagID
WHERE t.TagName IN (
   SELECT DISTINCT t2.TagName
   FROM GameTags gt2
   JOIN Tag t2 ON gt2.TagID = t2.TagID
   JOIN Plays p ON gt2.GameID = p.GameID
   WHERE p.UserID = @UserID
)
GROUP BY g.GameID
ORDER BY RecommendationCount DESC, AvgRating DESC, g.Price ASC
LIMIT 15;
```

```
SELECT g.Title, g.Price, COUNT(p2.GameID) as PlayCount
FROM Game g
JOIN Plays p2 ON g.GameID = p2.GameID
JOIN GameTags gt ON g.GameID = gt.GameID
JOIN Tag t ON gt.TagID = t.TagID
WHERE t.TagName IN (
   SELECT DISTINCT t2.TagName
   FROM GameTags gt2
   JOIN Tag t2 ON gt2.TagID = t2.TagID
   JOIN Plays p ON gt2.GameID = p.GameID
   WHERE p.UserID = @UserID
)
AND g.GameID NOT IN (
   SELECT GameID
   FROM Plays
   WHERE UserID = @UserID
)
GROUP BY g.GameID
ORDER BY PlayCount DESC, g.Price ASC
LIMIT 15;
```