Index Performance Summary

	Execution time before index	Execution time after index
list_users	88.2ms	0.2ms
login	342.7ms	0.9ms
list_fantasy_leagues	2.7ms	0.2ms

CREATE INDEX users_user_name ON users (user_name)

The inclusion of an index on the "user_name" column is appropriate for this query. Indexing the column allows for efficient searching and retrieval of data based on the specified condition in the WHERE clause. By creating an index on the "user_name" column, the database can quickly locate and access the relevant rows that match the given username, resulting in improved query performance.

CREATE INDEX fantasy_leagues_fantasy_league_name_idx ON fantansy_leagues (fantasy_league_name)

The inclusion of an index on the "fantasy_league_name" column is appropriate for this query. Indexing the column allows for efficient searching and retrieval of data based on the specified condition in the WHERE clause. By creating an index on the "fantasy_league_name" column, the database can quickly locate and access the relevant rows that match the given fantasy league name, resulting in improved query performance.

No other endpoints required indexing because the where clause in the queries refer to the primary keys of the tables, so an index is automatically created by the database. It would be unnecessary to manually create them.

(See screenshots below of query details with EXPLAIN ANALYZE)

List_users:

Before index:

```
1   explain analyze
2   SELECT *
3     FROM users
4     WHERE (user_name = 'cjones')
5     OFFSET 0
6     LIMIT 10
```

Results ⌄

```
QUERY PLAN

"Limit (cost=1000.00..9563.26 rows=5 width=80) (actual time=0.582..87.883 rows=10 loops=1)"

" -> Gather (cost=1000.00..9563.26 rows=5 width=80) (actual time=0.580..87.874 rows=10 loops=1)"

" Workers Planned: 2"

" Workers Launched: 2"

" -> Parallel Seq Scan on users (cost=0.00..8562.76 rows=2 width=80) (actual time=1.661..32.158 rows=9 loops=3)"

" Filter: ((user_name)::text = 'cjones'::text)"

" Rows Removed by Filter: 69778"

"Planning Time: 0.795 ms"

"Execution Time: 88.206 ms"
```

After index:

```
1   explain analyze
2   SELECT *
3     FROM users
4     WHERE (user_name = 'cjones')
5     OFFSET 0
6     LIMIT 10
```

Results ⌄

```
QUERY PLAN

"Limit (cost=4.46..24.10 rows=5 width=80) (actual time=0.058..0.084 rows=10 loops=1)"

" -> Bitmap Heap Scan on users (cost=4.46..24.10 rows=5 width=80) (actual time=0.056..0.080 rows=10 loops=1)"

" Recheck Cond: ((user_name)::text = 'cjones'::text)"

" Heap Blocks: exact=10"

" -> Bitmap Index Scan on users_user_name_idx (cost=0.00..4.46 rows=5 width=0) (actual time=0.041..0.042 rows=57 loops=1)"

" Index Cond: ((user_name)::text = 'cjones'::text)"

"Planning Time: 0.876 ms"

"Execution Time: 0.247 ms"
```

Login:

Before index:

```
1    explain analyze
2    select password
3          from users
4          where user_name = 'cjones'
```

Results ∨

QUERY PLAN

"Gather (cost=1000.00..9563.26 rows=5 width=65) (actual time=3.210..342.118 rows=57 loops=1)"

" Workers Planned: 2"

" Workers Launched: 2"

" -> Parallel Seq Scan on users (cost=0.00..8562.76 rows=2 width=65) (actual time=10.642..328.384 rows=19 loops=3)"

" Filter: ((user_name)::text = 'cjones'::text)"

" Rows Removed by Filter: 149981"

"Planning Time: 2.203 ms"

"Execution Time: 342.757 ms"

After index:

```
1    explain analyze
2    select password
3    from users
4    where user_name = 'cjones'
```

Results ∨

QUERY PLAN

"Bitmap Heap Scan on users (cost=4.46..24.10 rows=5 width=65) (actual time=0.120..0.800 rows=57 loops=1)"

" Recheck Cond: ((user_name)::text = 'cjones'::text)"

" Heap Blocks: exact=56"

" -> Bitmap Index Scan on users_user_name_idx (cost=0.00..4.46 rows=5 width=0) (actual time=0.104..0.104 rows=57 loops=1)"

" Index Cond: ((user_name)::text = 'cjones'::text)"

"Planning Time: 0.918 ms"

"Execution Time: 0.941 ms"

List_fantasy_leagues:

Before index:

```
1    explain analyze
2    SELECT *
3        FROM fantasy_leagues
4        WHERE (fantasy_league_name = 'Joey''s fantasy league')
5        OFFSET (0)
6        LIMIT (10)
```

Results ∨

```
QUERY PLAN

"Limit (cost=0.00..203.00 rows=7 width=32) (actual time=2.450..2.451 rows=0 loops=1)"

" -> Seq Scan on fantasy_leagues (cost=0.00..203.00 rows=7 width=32) (actual time=2.448..2.449 rows=0 loops=1)"

" Filter: ((fantasy_league_name)::text = 'Joey''s fantasy league'::text)"

" Rows Removed by Filter: 10000"

"Planning Time: 0.596 ms"

"Execution Time: 2.659 ms"
```

After index:

```
1    explain analyze
2    SELECT *
3        FROM fantasy_leagues
4        WHERE (fantasy_league_name = 'Joey''s fantasy league')
5        OFFSET (0)
6        LIMIT (10)
```

Results ∨

```
QUERY PLAN

"Limit (cost=4.34..26.14 rows=7 width=32) (actual time=0.099..0.100 rows=0 loops=1)"

" -> Bitmap Heap Scan on fantasy_leagues (cost=4.34..26.14 rows=7 width=32) (actual time=0.097..0.098 rows=0 loops=1)"

" Recheck Cond: ((fantasy_league_name)::text = 'Joey''s fantasy league'::text)"

" -> Bitmap Index Scan on fantasy_leagues_fantasy_league_name_idx (cost=0.00..4.34 rows=7 width=0) (actual time=0.095..0.095 rows=0 loops=1)"

" Index Cond: ((fantasy_league_name)::text = 'Joey''s fantasy league'::text)"

"Planning Time: 4.820 ms"

"Execution Time: 0.223 ms"
```