WEEK2
Task1: Query Pair.

1. **Cross Join vs. Join**

The reason for choosing this query pair is to investigate with different result for join operations. Considering the following expression, $(r * s) * v$ and $r * (s * v)$, if r is small, s is small and v is large. In that case, former expression would have a better CPU runtime than the other one. After investigation, the order of tables is actually influence a lot in JOIN query performance.

2. **Like optimizer with index concern**

Some pattern match in SQL can be enhanced as well by different query. Normally, people use LIKE to match the pattern in database. However, if the the matching range can be known, people can use mathematic operator >, < instead of using LIKE. However, in this case, consideration of index cannot be ignored. Cause it is auto-index on name in table city. Query would take advantage as well. Nevertheless, mathematic operator has risk. It is a way of hard code the solution. If everything is unknown, LIKE would provide a accurate result.

3. **Between, And, with Index issue**

The mechanism for "Between AND" and range are almost similar. According to the result, the CPU time are almost same. However, some operation can take a lot advantage by using index. After investigation, Between AND will have much less searching row by using index than without using index. The methodology of investigation is simply adding index on longitude accordance to my SQL file. And use "explain query plan" to check searching rows.

Task2: Summary with Plot
All queries produce the same results.
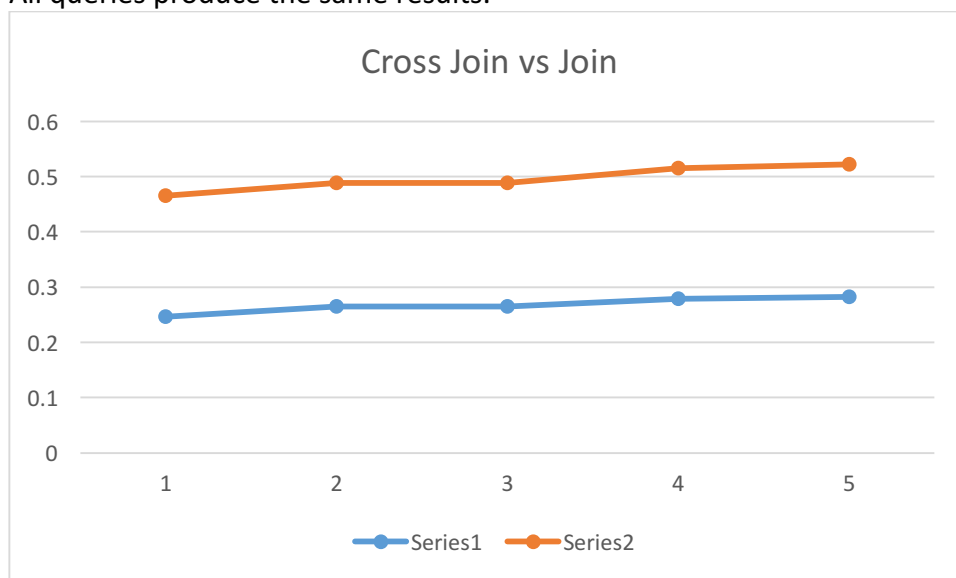
Series 1 is JOIN and series 2 is CROSS JOIN. Although JOIN is faster according to the plot, if the order of table switched. The result will be swapped as well. And therefore the order of tables affects a lot on performance issue in JOIN operation.
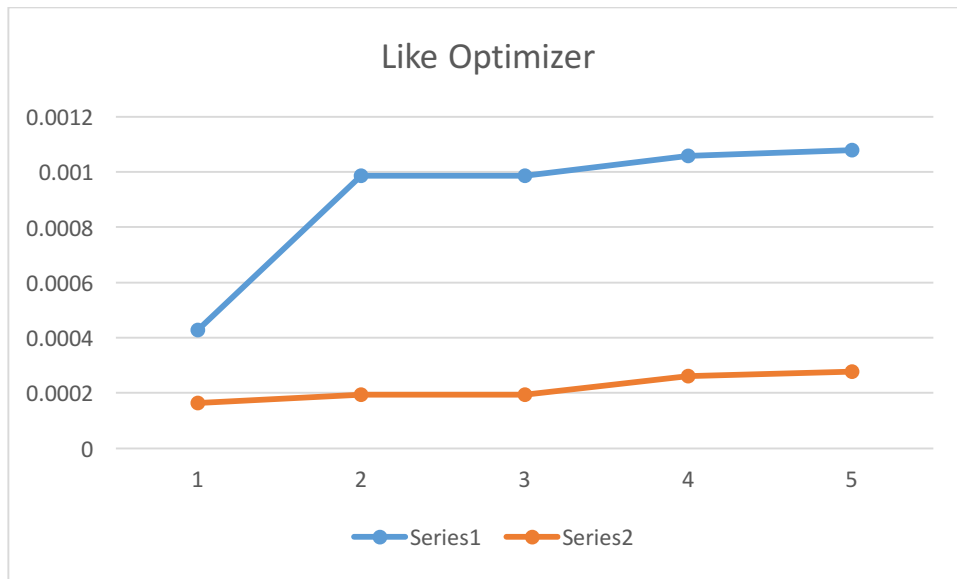
According to plot above, series 2 has less CPU time. And I t is using range instead of LIKE in query. Due to the consideration of auto-index on name, the difference between 2 queries is not that significant.
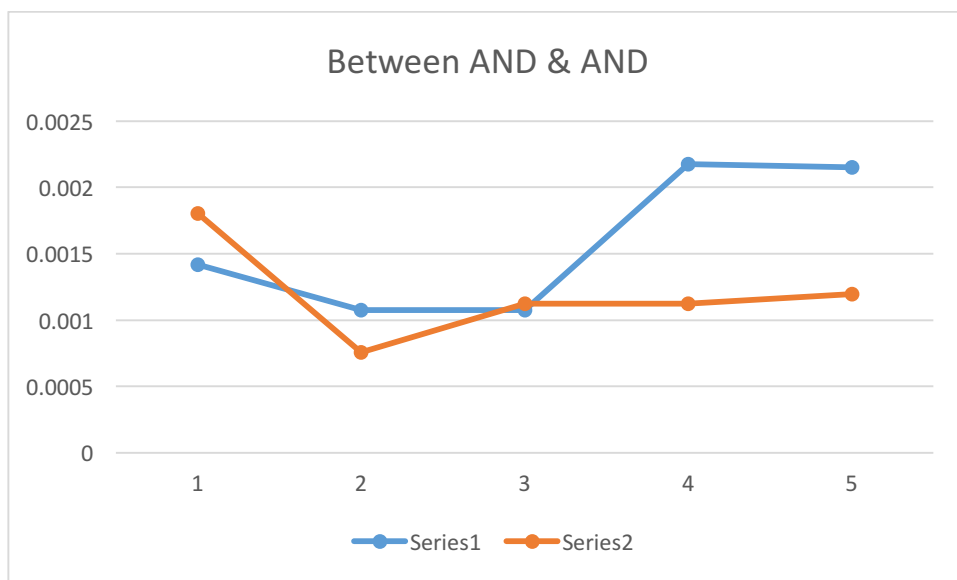
For this query optimization, index act key role. Index does not get involved in this output. But some investigation is made by explain query plan. Searching row are sharply decrease in both methods.