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   FINDINGS

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AN APPROACH TOWARDS EFFICIENT PREFERNCED DATA RETRIVAL BY PRESORTING

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ABSTRACT

Skyline query processing has become an important issue in database research. The popularity of the skyline operator is mainly due to its applicability for decision making applications. In such applications, the database tuples are represented as a set of multidimensional data points and the skyline set contains those points that are the best trade-offs between the different dimensions. Evaluating skylines, existing techniques primarily focus on skyline algorithms to produce skyline after complete scan of dataset where each tuple is compared with every tuple for Skyline selection. This techniques faces serious limitations, namely (1) Decision making lasts after complete dataset scan, and (that is why) (2) Skyline can only be computed after execution of other relational operator. Developed method PRESORT TO GET SKYLINE (PGS) introduced as an extension to existing Block Nested Loop (BNL) method by improve response time in answering skyline. We claim once a tuple is included in skyline candidate list no subsequent tuple can dominate it hence is not required to compare with tuples following it.

KEYWORDS

Skyline Query, Multidimensional Data, Relational Operator, Decision Making Applications.

INTRODUCTION

Skyline queries are a specific, yet relevant, example of preference queries and have been recognized as a useful and practical way to make database systems more flexible in supporting user requirements. This has motivated the development of many algorithms for the efficient skyline evaluation on large Datasets.

Skyline operator, returns a set of tuples not dominated by any other tuples, has widely been applied in preference queries in relational databases. Skyline has a history before introduced in database, as maximal vector or pareto operator [2,8,9]. Its implementation enables maximal vector applications to be built on relational database systems efficiently [6,7].

Given a set of hotels with the attributes of price (price) and distance to the beach (distance). Hotel A dominates hotel B if A.price ≤ B.price, A.distance ≤ B.distance, and strictly A.price < B.price or A.distance < B.distance. The most interesting hotels are called skyline hotels which are not better by any other hotels in price and distance.

It is proposed to build the Skyline operator on top of the other operator as Join and Order By in [3] in relational database. If we start the Skyline evaluation above all operations, then the total cost of the query is the sum of the query cost and Skyline computation. Additionally, this sequential execution causes the Skyline evaluation to be blocked by the other operators. We observe that efficient Skyline evaluation with other relational operator require a continuous execution of both Skyline and the other operator.

In this paper, our goal is to develop an algorithm, to behave efficient execution of skyline query in relational settings. We are aiming to develop an extension to basic BNL produced in [3], BNL requires scanning of the whole dataset to output the first Skyline object which blocks the result up to end of execution. Developed method Presort to Get Skyline (PGS) produced skyline results in pipelined fashion so fusion of skyline with other operators can be further performed.

Similar to BNL, our proposed method PGS also maintains a window and adopts multi-pass processing but has less bookkeeping overhead than BNL. We developed PGS with the idea, when a point (tuple) is added to the window it is already known that the point is non dominated as per preference. The window's points are used to eliminate stream points. Any stream point not eliminated is itself added to the window.

We arrange the tuples in an order by providing a score based on preferences. The tuples with a lower score have higher possibility to dominate a larger number of tuples. It is impossible for a point off the stream to dominate any of the points in the window. Any point is thus known to be maximal at the time it is placed in the window. So if lower score tuples are inserted to the candidates list first, the number of comparisons can be largely reduced that makes the filtering process much quicker. In addition, when a tuple is added to the candidate list of the window, it is for sure a Skyline point since this tuple cannot be dominated by any tuple that has not yet been presented. Such a scored list approach also enables the progressive output of skylines while BNL has to wait till all tuples are being compared. In regards to the window operation developed method does not replace tuples already in window.

RELATED WORK

In application of decision making user preferences consideration is important. Two areas are emerged for implementing preferences. One is using preference functions [1,4]. Preferences are defined by applying a score to each tuple based on attribute values. Many unrealistic preferences are than generated.

Other approach which attracted interest of database research community is based on Skyline Operator. The skyline operator is an elegant summary method over multidimensional datasets. Skyline queries are applied as popular and powerful paradigm for extracting interesting objects from a multidimensional dataset. Given a set r of d-dimensional objects (or points), the skyline of r is the set of nondominated, points in r where domination is defined as a point p dominates point pi if p is at least as good as pi on all the attributes of interest, and strictly better than pi on at least one attribute. SQL syntax for the skyline operator first introduced in [3];

The Skyline operator encapsulates the implementation of the Skyline of clause. Much of the recent Skyline work has focused on designing good algorithms [3,10] that are well-behaved in the context of a relational query engine. Nearest neighbor is closest database problem to skyline evaluation. The implementation uses both indexed and non indexed approaches. Using indexes has its own disadvantages of maintaining indexes.

The basic Block Nested Loop (BNL) introduced in [3] is straight forward way to compute the skyline. In BNL each data point P is compared with all the other data points and report P as a Skyline point if P is not dominated. In implementation of BNL a window of candidate (Skyline) is maintain in main memory and each data element in data set is compared with every candidate element one by one. When a data point P is evaluated, P is compared against all the candidate points in the window. There are three cases:

Case 1 P is dominated by a candidate point in the window, it is discarded immediately without further comparison with other candidate points.

Case 2 P dominates some candidate points in the window, the dominated candidates points are removed from the window and P is inserted into the window as a new candidate point.

Case 3 P is neither dominated by nor dominates any candidate point in the window; P is inserted into the window as a new candidate point.

After all the data points are processed, the candidate points in the window are reported as the skyline. When the window grows larger than the main memory, BNL adopts a temporary file to store the candidate points. Specifically, when the window is full the new candidate point found in Case is written to the temporary file.

After the dataset is scanned, all the candidate points in the window which are processed before the creation of the temporary file are output as part of the skyline. Then, BNL evaluates all data points in the temporary file in the same way again in next pass until no temporary file is created. Finally, all candidate points in the window are output as part of the skyline.

Example 1 We use an example to illustrate BNL algorithm. Consider preference point is close (near) point. Consider computing Skyline of the given dataset shown Table 1 by BNL with window size 3 (can keep 3 points at maximum).

The dataset is processed in the order of the subscript number of each data point. Initially, P1 is inserted into the window as it is empty. The next data point, P2, is processed. Since P1 is far in both dimensions P2, P1 is removed and P2 is inserted into the window. Similarly, after P3 is processed, only P3 is in the window. Then, P4 is inserted into the window as it is not dominate by any data point in the window (i.e., P3). After that, P5 and P6 are processed in the same way and P6 is inserted into the window. When P7 is processed, it is written to the temporary file as the window is full with data points (P3, P4, and P6). The time stamp of this temporary file is 7. At the end of this iteration, the data points in the window are P3, P8, and P9, and the temporary file contains data points P7 and P10. Then, the data points in the window which is processed before time stamp of the temporary file (i.e., 7) are output as Skyline points. In this case, P3 is output. After that, BNL continues to process the temporary file in the same way till no data point is remained in any temporary file. The Skyline result is (P3, P8, P9, and P10). To speed up the comparisons between the data points in question and the candidate points, the window is organized as self-organizing list. In this list, when a candidate point is found dominating other data points, it is moved to the beginning of the list. Consequently, it is first compared when evaluate the next data point. This variant reduces the number of comparisons as the data points which dominate more others may be compared first.

Only Skyline tuples are added to list and same time pipelined to output, all we need is that we can check subsequent tuples for whether they are dominated by this tuple. For this, we only need the tuple's Skyline attributes. Real data will have many attributes in addition to the attributes we are using as Skyline criteria. Therefore we are not maintaining the actual tuple in the window, only Skyline attributes are projected and kept in window for comparison. The Skyline generation worked only for numerical data so Integer and float values are only taking part in Skyline computation.

PRELIMINARY: The property described in [3], for any monotone scoring function M →R if p ∈ M maximizes that scoring function, then p is in the Skyline. In addition, for every point p in the Skyline, there exists a monotone scoring function such that p maximizes that scoring function. In other words, no matter how you weigh your personal preferences towards price and distance of hotels you will find your favorite hotel in the Skyline and Skyline does not contain any hotels which are nobody's favorite. We use this property for sorting tuples on their scores (with a scoring function).

Again we observe that, any nested sort of Relation R over the Skyline attributes $a_1, a_2 ..., a_k$ (sorting in descending order on each), as in the figure 1.1 is a topological sort with respect to the dominance.

Justification of the above is:

Let us assume domains of a_i are define in reals over 0..1 non inclusive. Let a nested query in figure 1.1 is applied.

As R be a finite table there is an $\varepsilon > 0$ such that

for $i \in 1.....k$ for all $r, t \in R$ if $r(a_i) < t(a_i)$ then $t(a_i) - r(a_i) > \varepsilon$.

Consider a scoring function

$T(r)= \sum_{i=1}^{k} (\varepsilon/k)^{i-1}[a_i]$

If $r(a_1) > t(a_1)$ than $T(r) > T(t)$

i.e. T gives total preference to a_i over all $a_{i+1}.....a_k$ This is equivalent to nested sort.

TABLE 1: SKYLINE OF THE EXAMPLE DATASET USING BNL

Point	X dim	Y dim
P1	10	9
P2	6	8
P3	1	7
P4	3	6
P5	7	6
P6	4	5
P7	8	4
P8	2	3
P9	5	2
P10	9	1

This observation leads to our concept, As a result of nested sort query a current tuple is dominated by one of the tuples preceded it only. No following tuple to it will dominate current tuple. An external sort is a well known component in relational engine which can be called using an ORDER BY clause in SQL adaptation of sort need not require any addition in optimizer.

Figure 1 An order by query

SELECT * FROM R

ORDER BY a_1 desc,..., a_k desc;

Let F be dominance function in relation R with n tuples. F(t) can range from 0 to n-1 i.e. dominance of tuple t under definition of F ranges from none to all tuples. If t is input in first pass for dominance at least F(t) tuples get eliminated. Again F(t) is non additive i.e. window tuples may dominate same tuples in common. If we maximize cumulative F of tuples in window will improve reduction factor [5]. We already implemented it comparing to sorted data.

Again with dominance definition even for non Skyline F may high (any non Skyline point may also dominate some other non skyline). For a non Skyline tuple r there exists at least a t such that $F(t) \succ F(r)$ and all s dominated by r all also dominated by t under F. Every time a tuple replaced by a new tuple in window, F for new tuple is higher than a maximum F over the tuple it is replacing when window is full cumulative F is fixed for next pass, and strategy is to fill the window with high F.i.e. high order in sorted list must appear first. It is accomplished by sorting of tuples in ascending order of F. If a tuples F is known to sort off course F will be monotone. Calculating F for each tuple is costly but we can estimate probability that a given tuple dominate an arbitrary tuple.

Probability of $t[a_i] \succ r[a_i]$ is $t[a_i]$ under the assumption that domain of tuple is normalized between reals 0..1,and data in dataset is uniformly distributed and each data is independent.

Probability $t \succ r$ considering all dimensions is

$\prod_{i=1}^{k} t[ai]$

This probability is monotone and can be computed from each tuple. The definition of monotone function is that addition can be applied only on Skyline attributes. So the monotone function can defined as

$E(t) = \sum_{i=1}^{k} \ln(t(ai) + 1)$ has same order as ordering by probability, and as E is an Entropy we use it as Entropy Scoring for our implementation.

Example 2 Take the same dataset shown in Table1 as example. The corresponding normalized coordinates and entropy value of the data points are listed in Figure Suppose the window size is 3 and now after sorting on the entropy values the processing order of data points is p8, p3, p9, p10, p4, p6, p7, p5, p2, and p1. Clearly, the first three points p8, p3, and p9 do not dominate each other. So, all of them are inserted into the window and the window is full now. Then, p10 is processed and it is written to the temporary file as it is not dominated by any data points in the window. After that, all other data points are processed and discarded due to each of them is dominated by one of p8, p3, and p9. Now, the first iteration is done. In the beginning of the next iteration, all the data points in the window are output as the Skyline points as they are processed before the temporary file. Since p10 is the only data point in the temporary file, the process terminates after it.

TABLE 2: CALCULATING ENTROPY ON EXAMPLE DATA

ID	Coordinate	Normalized Coordinate	Entropy Value
P1	10,9	1.0.0.9	1.4
P2	6,8	0.6,0.8	1.06
P3	1,7	0.1,0.7	0.6
P4	,6	0.,0.6	0.7
P5	7,6	0.7,0.6	1.00
P6	4,5	0.4,0.5	0.74
P7	8,4	0.8,0.4	0.92
P8	2,	0.2,0.	0.44
P9	5,2	0.5,0.2	0.59
P10	9,1	0.9,0.1	0.74

PRESORT TO GET SKYLINE (PGS)

As studied in previous section BNL produce results only after a complete cycle of scanning. We attempt to improve BNL with early Skyline result generation. We developed here a new algorithm with the objective of early results on domination test, so the Skyline points are continuously produced and may further combined with other database operation.

In the proposed PGS execution sorting is applied first on input set; Candidate points are inserted into the list in sorted order next and sorted stream is filtered for the non dominance as in BNL. A window is than created as in BNL to hold the Skyline tuples.

The Skyline objects are output to a window. The window is a data structure used to hold the Skyline tuples. We applied a doubly list for implementation of window. The sorted tuples are sweep and checked against tuples in window; objects put into the window are guaranteed to be in the Skyline If current tuple is dominated by any of the window tuple can easily be discarded otherwise it is a Skyline tuple. The current tuple if not discarded can be added as an Skyline and also pipelined to output stream. Each object is compared only with the tuples existing in window not with all the tuples preceded is due to the transitive property [5] of Skyline dominance relation.

If the window is full and cannot accommodate the current tuple can be move to another temporary file. Next comparison is takes place with the elements of window and again either discarded or keeps in window or temporary file. At the end if all the tuples are compared and no temporary file exists we have completed with our results else the algorithm repeats with opening the temporary file as input stream. Multiple passes are only required if window is not large enough to hold all the Skyline tuples.

THE ALGORITHM

Input: (a) Data set D with n tuples.(List of data)
(b)An external sort method (Quick sort is used)
Output: (a) set of Skylinepoints

```
I presot = sort(I); //Presorting dataset
Set O = Φ; W = Φ; Temp = Φ//Initialization
while ¬EOF(I presot )//Loop
p = next(I presot )
isSkyline = true
for each q ∈ W
if q ≻ p //Dominance test in window
free(p);
isSkyline= false;
Break;
elseif p ≻ q //dominated p.
Release(W,q);
If isskyline
If hasfreespace(W)
Add(W,p);// include p in window.
Else
Append(T,p) // write p to temporary file for second pass.
Free(p)//remove p from dataset.
Append(O,p)
EOF(Ipresot)
Ipresot ← Temp ; Temp ← Φ ;
W ← Φ;
Return (O);
```

Experiment and RESULTS: With experiment we provide the features of our developed method and compare with basic BNL on early skyline result generation criteria.PGS produces early results as soon as catches as skyline candidate. Skyline algorithm execution. Our experiment is based on following features.

- Our experiments are carried out on an Intel Pentium IV 2.2 GHz duo CPU machine with 2GB main memory and a 80 GB hard disk, running Microsoft Windows XP.
- We implemented the algorithm on a random dataset on student marks using C++ with 3, 5,7 dimension of Skyline query with 419 Skyline points in d, 876 Skyline points in 5d and 9816 Skyline in 7d comparisons.
- We consider sort phase and Skyline phase as two different operations. The time required to sort the data is included in the execution time shown.
- We execute the methods on 50,000 tuple dataset. A tuple is of 100 bytes with 10 integer values (40 byte) and a 60 byte string value.
- Both behave similar in and 5 dimensions while in 7 dimension the execution time differ, PGS perform better to BNL.
- We observe when BNL is given more main-memory allocation and thus, its window is larger—its performance deteriorates.

FIGURE 2: EXECUTION TIME VS. WINDOW SIZE IN BNL AND PGS

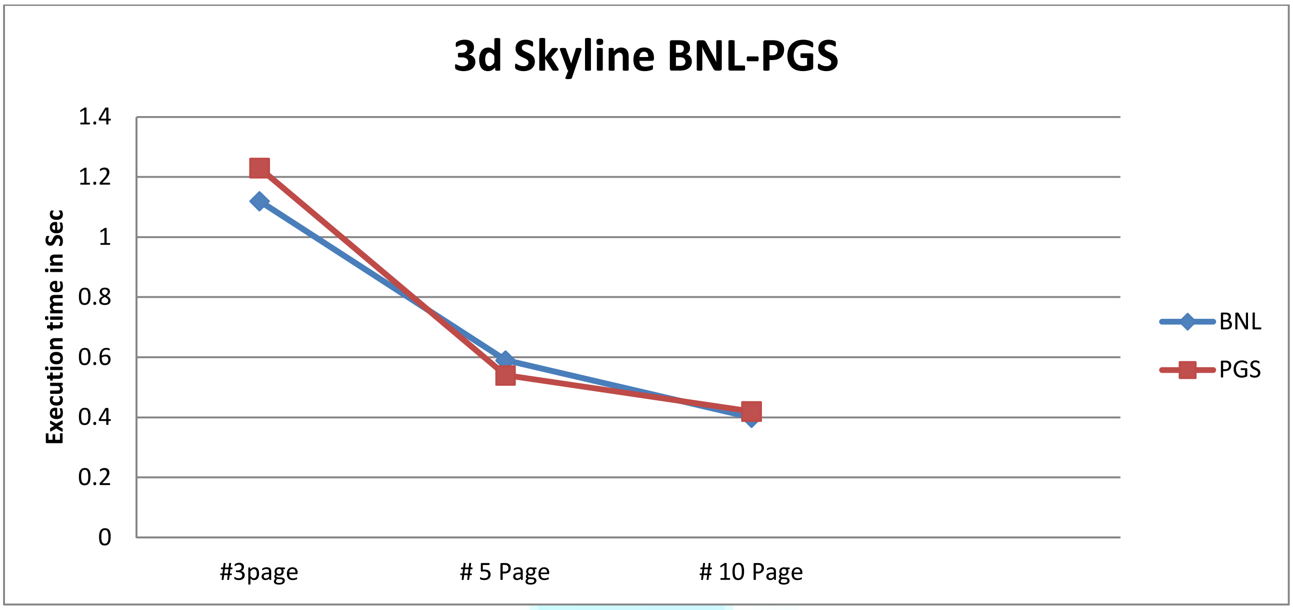


FIGURE 3: COMPARISON BNL AND PGS

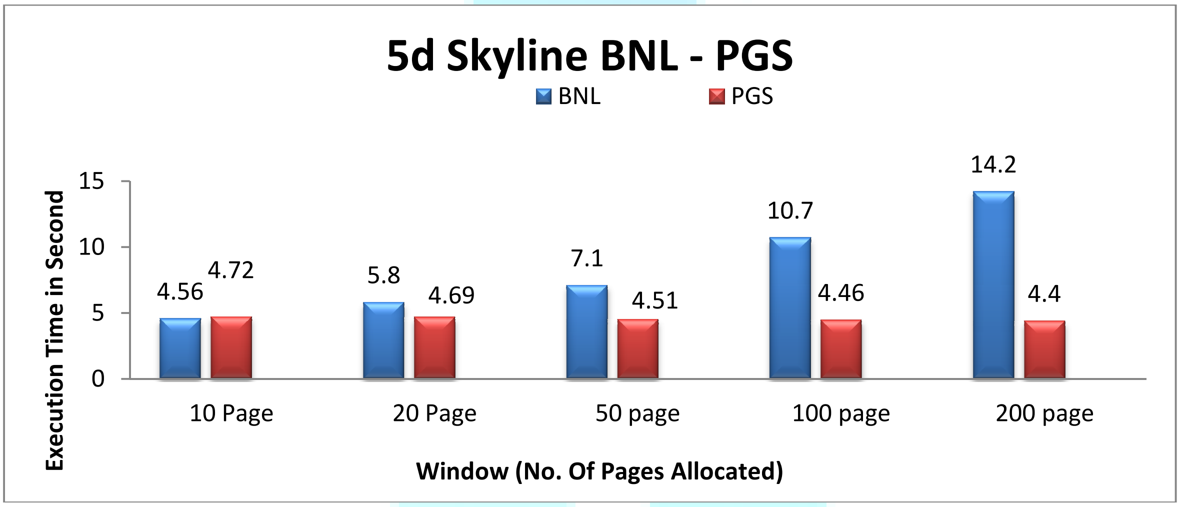
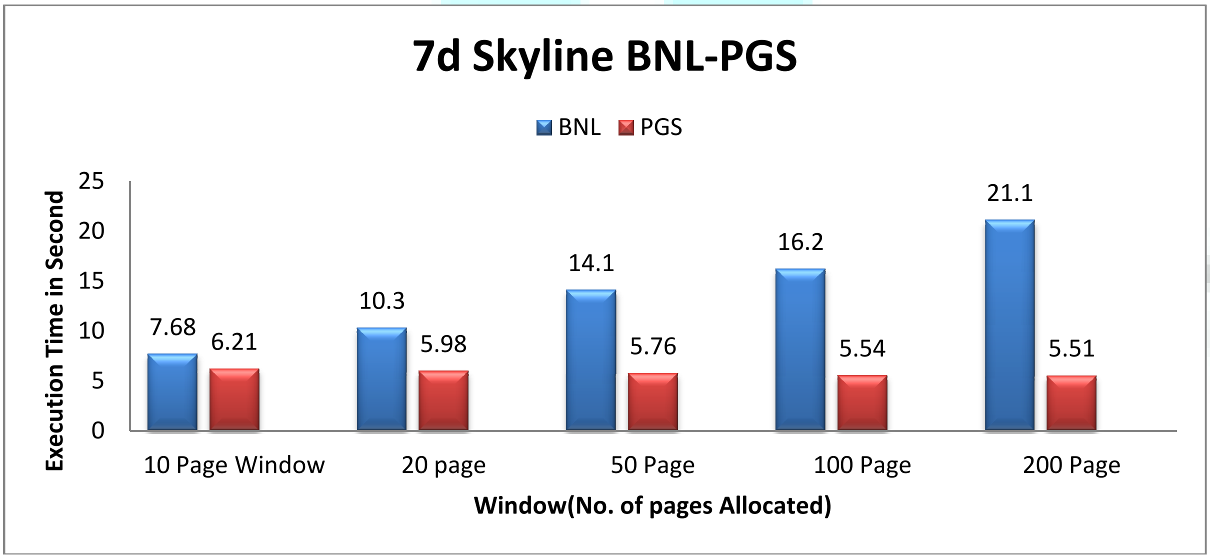


FIGURE 4: BNL-PGS EFFECT OF MEMORY ALLOCATION



CONCLUSION

Skyline operator offers a good start to provide preference query results in relational database. There may be ways to reduce dominance check. We implemented as improvements on BNL. BNL differ with our developed method as BNL is comparing each tuple with other tuple using replacement policy while developed method operate on sorted data set. In PGS management of window is largely simplifies and points in the skyline can be progressively returned without having to wait for all the input to be read

We believe with performance test that our algorithm is a good start to incorporate Skyline computation within other relational operators.

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