SELF TUNING MEMORY MANAGEMENT FOR DATA SERVERS

By

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Introduction :

What is memory tuning ?

When you run multiple instances on a computer,each instance dynamically acquires and frees memory to adjust for changes in the workload of the instance.

Need for memory tuning :

- In case of complex software.
- In case of data server in multi-user mode and multiple data-intensive decision support queries.
- Increasing data volumes and critical decision.
- Thrashing ,memory bottle Memory contention neck.
- Automatic tuning decisions reduce the cost of human administration.

Self – tuning server caching :

- Memory in data server is for caching frequently accessed data to avoid disk I/O.
- Cache manager is to maximize the cache hit ratio.
- The most used replacement is LRU(Least Recently Used) algorithm.

a) Sequential scan over large set of pages .

b) Random access to pages sets with highly skewed cardinalities .

Self – tuning server caching :

1) Introduction.
2)Need for memory tuning.
3)Self –tuning server caching.
4)Automatic tuning of server and cache memory.
5)Exploiting distributed memory.
6)Integrating speculative prefetching with caching.
7)Self – tuning caching and prefetching for web based systems.
8)Conclusion.
9)Bibliography.

- To overcome these deficiencies –had developed – no of tuning methods but they are not fully self –tuning .

The various approaches are :

1) PANDORA :

- This approach relies on explicit tuning hints from programs.
- This is an hint processing approach. Eg: a query processor engine.
- The difficulty is hinting passing approach is very limited and bears high risk.

Self – tuning server caching :

SISYPHUS :

- This approach aims to tune the cache manager by portioning the overall cache into separate "Pools".

- It works well with partitioning index Vs data pages.

•But the difficult - appropriate pool size and proper assignment of page classes of pools.

SPHINX :

- It abandons LRU and adopts a replacement policy based on access frequencies.

- LFU (Least frequently used) policy –optimal for static work load ----pages have independent reference probabilities.

Self – tuning server caching :

- The problem in sphinx can also be improved by using a “Nike approach” - LRU-k algorithm.
- It uses three methods observe-predict –react.

Observation :

- It keeps limiting on relevant page’s reference history – k last reference time points.
- ‘Relevant’ - all pages that are currently in the cache plus some more pages that are potential caching candidates.
- Five - minute rule -last 5 mins can be safely discarded.

Self – tuning server caching :

Predictions :

- Page's specific access rate is known as page's heat.
- Page's heat(p) = k / now – tk.
- Probability for accessing the page within next T time units is

  1- e ^ - (heat(p) * T).

- optimal to rank pages - near-future access probabilities.

Reaction :

- When page - freed up in cache LRU-k algorithm replaces the pages with smallest value for above estimated probability.

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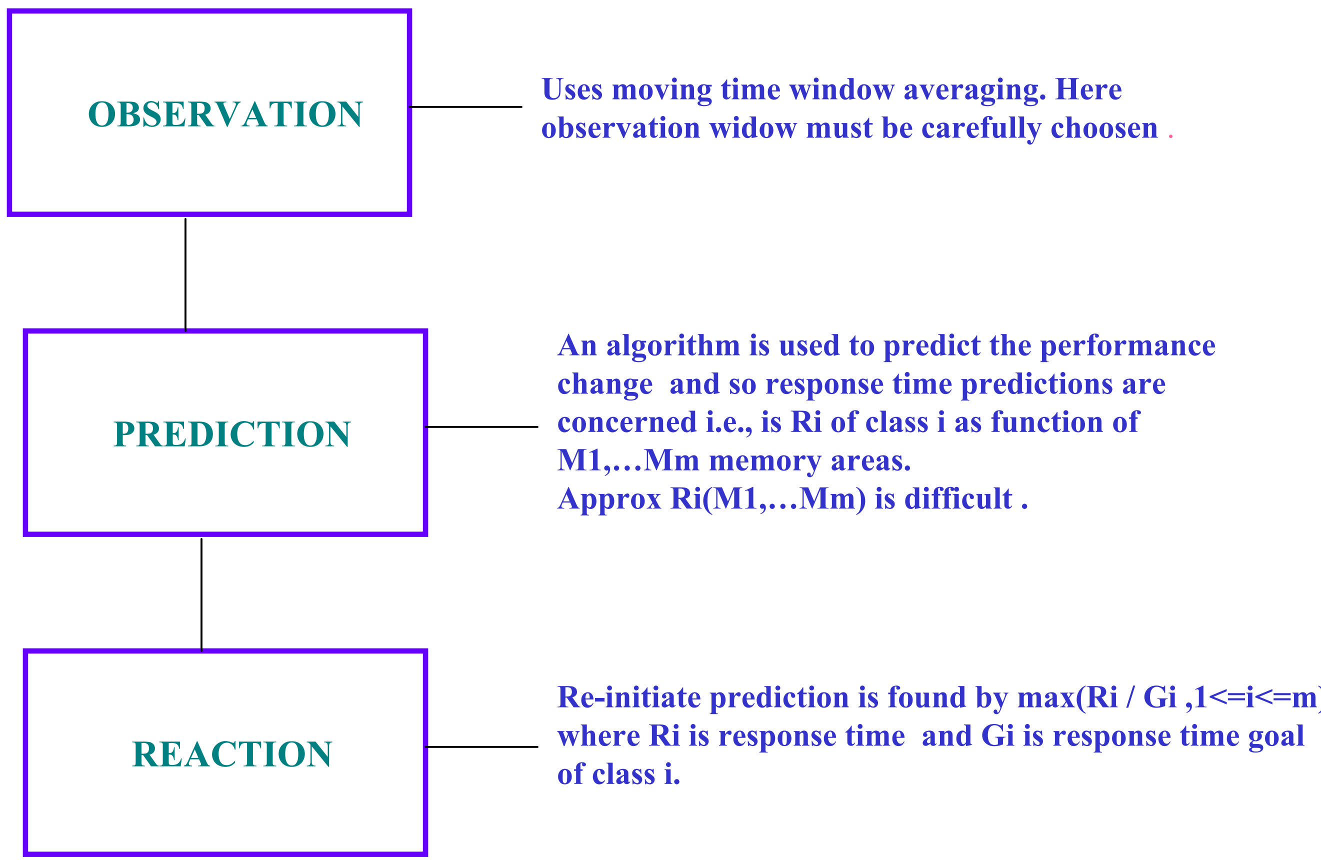
- This algorithms can be generalized with variable size caching (documents) rather than pages.
- We calculate temperature of document.
- Caching documents are simply ranked by their temperature.

Automatic tuning of server and cache memory :

- A data server needs to manage also working memory for long running operations.
- Memory management should not focus on single global performance .
- It has consider to different workload classes.
- System cannot automatically infer importance of each class - needs human administrator.
- Mechanism for handling multiple work load classes - class specific memory areas.
- The partition is merely conceptual and not physical - memory area - shared by multiple workload classes.

Automatic tuning of server and cache memory :

- Approaches for automatic memory performance is described as a feedback loop.



Exploiting distributed memory :

Two cases :

- High end data servers implemented on server clusters.
- Collection of independent servers with data replicated across all of them.
- Distributed caching algorithm –controls dynamic replication of data objects in (fixed sized pages or dynamic documents) caches.

•Two approaches :

•1) egoistic caching .

•2) altruistic caching.

Exploiting distributed memory :

Egoistic :

- Each server runs on local cache replacement algorithm –LRU and LRU-k .
- It views remotely cached data that is not locally cached.
- It ends with hottest data fully replicated and in all caches with little space left out for others.

Altruistic :

- It aims at maximizing this replication by giving preference in the local cache replacement to data.
- That data should not be cache resident in different server.

Exploiting distributed memory :

- For high band width network altruistic approach is better – affordable overhead.
- In fastest interconnect it becomes congested under high load.
- Mathematical cost model -it decides which method is useful under the current workload and system settings.
- Benefit is proportional to mean response time of data and requests over all servers.
- This model includes disk queuing the entire approach can even contribute to disk load balancing .

Integerating speculative prefetching with caching :

- Caching reduces overall disks I/O load.
- To reduce response time prefetching is used.
- Prefetching brings relevant data into memory already before it is explicitly required.
- It pays off well - high latencies data request.
- It is beneficial with a certain probability like in case of sequential scans not in case of near access patterns of ongoing operations or client sessions.

Integerating speculative prefetching with caching :

- Alternative method is to access near future access probabilities -stationary heat statistics or corresponding temp value.
- The method is temperature based vertical data migration in.
- It keeps a list of the top temp non cached data units and considers their prefetching in desc order of temperature.
- Prefetching is initiated only when the corresponding documents temp exceeds the temp of the documents.
- When latencies of fetching non-cached documents vary cost benefits consideration should be further refined explicitly.

Integerating speculative prefetching with caching :

- With length T the expected number of access to document d within time 'T' is

  Nspec(d) = heat (d) * T

- Benefit of prefetching document

  d = Nspec(d) / size(d) * Fetch_time(d,v)

- Where Fetch_time(d,v) is the estimated time for accessing d on its "home location".

- Where v can be secondary storage ,an online volume in tertiary storage or offline volume .

Integerating speculative prefetching with caching :

- The division by size(d) is normalization per cache space unit.
- This method is for aggressive prefetching and not for speculative.
- Here overhead is low comparable to LRU-k bookkeeping.

Self – tuning caching and prefetching for web based systems :

- When servers are accessed over the web or use tertiary storage incur very high latency.
- Stochastic prediction for near future requests must be more “aggressive” but needs to be more “accurate”.
- A richer class of models used is Markov chains.
- Markov chain based algorithm has been investigated for prefetching and caching.
- In prior methods they focussed on reference pattern of a single client and assumed discrete time .

Self – tuning caching and prefetching for web based systems :

- McMin (Markov-chain based Migration for near line storage) -different interaction speed of clients - CTMC.

- In web based access to a digital library –CTMC captures variability.

- It is possible to compute both the expected number of near future access to a document d, Nspec(d) - appropriate precomputations.

- The (d,Nspec(d)) both of these values can be aggregated over multiple CTMC models one for each active client session and "arrivals","departures" as separate sessions.

Conclusion :

- The methods - geared for centralized, high speed interconnected and widely distributed data servers.

- The common method we followed is :
- Observation – online statistics
- prediction – mathematical models
- Reaction – feed back loop

- Space need for online statistics must be carefully controlled.

- CPU time over head of predictions may be a critical factor.

- Self tuning algorithms will penetrate products and contribute towards zero-admin and trouble -free servers.

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ANY QUESTIONS

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Thank you