



بسم الله الرحمن الرحيم

THE NATIONAL RIBAT UNIVERSITY

College of Graduate Studies and Scientific Research

# **Web Cache Replacement (Average Least Frequently Used Removal from Cache Using Intelligent Agent)**

A thesis Submitted Toward Award of Doctor of Philosophy  
in Computer Science

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## DECLARATION

I declare that this thesis entitled "*Web Cache Replacement (Average Least Frequently Used Removal from Cache Using Intelligent Agent)*" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature:.....

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Date: .....

## **DEDICATION**

This thesis is dedicated to:

- ✓ My beloved Allah Almighty for being my refuge and my rock.
- ✓ My mother Amna Mohammed Dahabe and my father Salah Abdalaziz Khaleel for their resilience in insisting to educate me and my siblings.

## **ACKNOWLEDGMENT**

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## **ABSTRACT**

The rapid development of the Internet needs to meet development and improvement of techniques to increase the performance of browsing

and decrease the overload on the network traffic, all that is to increase the general performance, this need depends on the cache memory in any site like (client, proxy, original server). Cache memory is one of storage hierarchal with high speed and limited size.

To overcome this situation, Web caching techniques has been used. Web cache reduces the high traffic over the Internet so that users can access the web content faster. The main purpose of cache is to place the copy of objects near to the client, so that web users can access the objects easily, without the request going to the web server.

The ALFUR replacement algorithm is developed by taking advantage of LFU, LRU and SIZE cache replacement algorithms. This algorithm separates the operation of the algorithm into three main agents, that we use it because to have the benefit of agents. The first agent is the monitor agent (reader agent and analyzer agent), this agent reads and calculates the average of object frequency, average time of request, time stamp and average web object size. After that it sends these values to the removal agent which is the second agent; to take the removal decision. The optimal web object selected for removal depends on rules from the cache. The third agent is the performance agent which measures the performance of the ALFUR cache replacement algorithm in terms of hit ratio and byte hit ratio.

The algorithm has been tested using five samples of workload generated using Webtraff simulator, these samples represented the user's requests and cache sizes.

The results of this dissertation show that when the cache size increases, the general performance of ALFUR increases as well.

The result of this dissertation show that ALFUR has better performance than LFU when cache size equals to 6MB with ALFUR having 85.83% HR, 60.31% BHR, and LFU having 40.94% HR, 42.33% BHR .

ALFUR is better than LFU with +44.89% HR and +17.98% BHR.

ALFUR is in its worst result when cache size equals to 800MB with ALFUR having 34.75% HR, 16.02% BHR, and LFU having 47.29% HR, 47.00% BHR .

ALFUR is worse than LFU with -12.54% HR and -30.98% BHR.

The average rate of ALFUR is higher than the averages of the other replacement algorithms (LFU, LRU, SIZE, and PCCIA) with 72.58% HR and 43.77% BHR.

## المستخلص

التطور المتسارع في الانترنت يجب مجابهته بتطوير في التقنيات لزيادة الاداء في التصفح عبر الانترنت وتقليل الضغط على مسارات الشبكة وكل ذلك لزيادة الكفاءة العامة، وذلك يعتمد على الذاكرة المخزنة الموجودة في اي جهة سواء كانت (في الخادم، الوكيل، الخادم الاصلي) الذاكرة المخزنة هي احد هيكليات التخزين بسرعة عالية وحجم محدود.

لمعالجة هذه الحالات، تم استخدام تقنيات الذاكرة المخزنة للصفحات. استخدام تقنيات الذاكرة المخزنة تقلل من زيادة الضغط على السمارات في شبكة الانترنت ولاجل ذلك يستطيع المستخدم الوصول الى محتويات صفحة الانترنت بسرعة عالية، الغرض الاساسي من استخدام الذاكرة المخزنة هو لجعل نسخة من الكائن (الصفحة) قريبة من الزبون وبذلك يستطيع المستخدم بالوصول للصفحة بسرعة وسهولة بدون ان يذهب طلب الصفحة الى الخادم الرئيسي.

خوارزمية التبدل ALFUR تستخدم للاستفادة من مميزات كل من خوارزميات الابدال LFU,LRU,SIZE هذه الاستراتيجية تقسم عمليات الخوارزمية على ثلاث وكالات للاستفادة من خواص استخدام الوكالة ايضا الوكيل الاول هو وكيل المراقبة ويحتوي بداخله على وكيلين هما وكيل القراءة و وكيل التحليل وهذا الوكيل يقوم بقراءة وحساب متوسطات عدد الترددات و زمن طلب الصفحات و حجم الصفحات وبعد ذلك يقوم بإرسال هذه القيم الى الوكيل الثاني وهو وكيل المسح الذي يقوم باتخاذ القرار الامثل لمسح الصفحة من الذاكرة المخزنة. الوكيل الثالث يقوم بحساب اداء خوارزمية المسح ALFUR .

هذا النموذج تم اختباره على خمسة نوع من العينات الذي تم توليدها باستخدام المحاكى webtraff هذه العينات تمثل طلبات المستخدم و حجم الذاكرة المخزنة. مقياس الاداء القياسي Hit ratio و Byte Hit ratio يتم استخدامهم لحساب اداء الذاكرة المخزنة.

توضح النتائج انه كلما زاد حجم الذاكرة المخزنة زاد معدل الاداء العام لخوارزمية ALFUR ونستنتج من نتائج هذه الدراسة ان خوارزمية ALFUR تحقق افضل نتيجة من خوارزمية LFU اذا كان حجم الذاكرة المخزنة 6MB وذلك حيث ان حيث ان  $HR = 85.83\%$  و  $BHR = 60.31\%$  ومعدل الـ HR لخوارزمية LFU  $40.94\%$  والـ BHR تعادل  $42.33\%$  بمعدل زيادة تقدر بـ  $HR + 44.89\%$  و  $BHR + 17.98\%$  واسوء نتيجة لخوارزمية ALFUR اذا كانت حجم الذاكرة المخزنة 800MB وذلك حيث ان  $HR = 34.75\%$  و  $BHR = 16.02\%$  ومعدل HR لخوارزمية LFU  $47.29\%$  ومعدل الـ BHR  $47.00\%$  بمعدل نقصان تقدر بـ  $HR - 12.54\%$  و  $BHR - 30.98\%$  وسبب هذه النتيجة بانه يوجد متوسط التكرارات فرقتها كبير جدا من باقي التكرارات.

توضح النتائج النهائية لخوارزمية ALFUR انها افضل من بقية الخوارزميات عند مقارنتها  
بخوارزميات المسح (LFU,LRU,SIZE,PCCIA) ان القيمة المتوسطة للنتائج =HR 72.58%  
=BHR 43.77% .



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## ABBREVIATION

Abbreviate	Full Name
ABLE	Agent Building and Learning Environment
AI	Artificial Intelligence
ALFUR	Average Least Frequently Used Removal
AV	Agent/Role view
BHR	Byte Hit Ratio
BN	Bayesian network
CCR	Correct Classification Rate
GB	Gigabyte
GDS	Greedy-Dual-Size
HR	Hit Ratio
HTML	Hypertext Markup Language
HTTP	Hypertext Transfer Protocol
IE	Internet Explorer
IV	Interaction view
JADE	Java Agent Development
LFU	Least Frequently Used Algorithm
LRU	Least Recently Used Algorithm
MAL	Multi Agent Learning
MARS	Multivariate Adaptive Regression Splines
MAS	Multi-Agent Systems
MB	Megabyte
MF	Member Function
PCCIA	Proxy Cache Cleanup Improvement using an Agent-based Model
SIZE	Size Algorithm
UML	Unified Modeling Language
URL	Uniform Resource Locator
WWW	World Wide Web