



**Tribhuvan University
Institute of Science and Technology**

**Analyzing Anomalous Behavior of Least Recently Frequently
Used (LRFU) Page Replacement Algorithm**

Dissertation

Submitted to:

Central Department of Computer Science and Information Technology
Kirtipur, Kathmandu, Nepal

In partial fulfillment of the requirements for the Master's Degree in
Computer Science and Information Technology

by

Kepisee Thapa
CDCSIT, TU
2013, July 30



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(July, 2013)

Supervisor

Mr. Arjun Singh Saud



Tribhuvan University
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Central Department of Computer Science and Information Technology

Student's Declaration

I hereby declare that I am the only author of this work and that no sources other than the listed here have been used in this work.

Kepisee Thapa

Date: 2013 July 30

Supervisor's Recommendation

I hereby recommend that this dissertation prepared under my supervision by Kepisee Thapa entitled "Analyzing Anomalous Behavior of Least Recently Frequently Used (LRFU) Page Replacement Algorithm" in partial fulfillment of the requirements for the degree of M. Sc. in Computer Science and Information Technology be processed for the evaluation.

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Mr. Arjun Singh Saud

Date: 2013 July 30



Tribhuvan University
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Central Department of Computer Science and Information Technology

LETTER OF APPROVAL

We certify that we have read this dissertation and in our opinion it is satisfactory in the scope and quality as a dissertation in the partial fulfillment for the requirement of Masters Degree in Computer Science and Information Technology.

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Abstract

In most of the page replacement algorithms, number of page faults decreases as the memory size increases. But in some algorithms it is just opposite i.e. increasing in memory size leads to increase in number of page faults. This unexpected result is known as anomaly. LRFU page replacement algorithm also showed anomalous behavior some times. This study successfully identified reason behind the anomalous behavior of LRFU and adopted the algorithm so that anomalous behavior had avoided.

In this dissertation a sample workload had listed where LRFU shows anomalous behavior. Besides this, experiment is done with LRFU using real memory traces such as cs, 2_pools, sprite and multi to identify anomalous behavior and showed that LRFU shows an anomalous behavior with real memory traces also. And, adaptation is made to existing LRFU so that an anomalous behavior can be avoided. Finally, the dissertation compares LRFU and Adapted LRFU with real memory traces cpp, 2_pools, sprite and multi and showed that LRFU and Adapted LRFU had comparative performance. Further, it is also showed that Adapted LRFU shows better performance with strong locality of workload such as sprite.

Keywords: Cache memory, Virtual memory, Anomalous behavior, LRU, LFU, LRFU, Adapted LRFU.

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List of Abbreviations

2Q	- Two Queues
AI	-Artificial Intelligence
ARC	- Adaptive Replacement Cache
CPU	-Central Processing Unit
CRF	-Combined Recency Frequency
EELRU	- Early Eviction LRU
FIFO	- First In First Out
FBR	- Frequency Based Replacement
HR	- Hit Rate
IDE	- Integrated Development Environment
IRR	- Inter- Reference Recency
JRE	- Java Runtime Environment
LFU	- Least Frequently Used
LIRS	- Low Inter-reference Recency Set
LRFU	- Least Recently Frequently Used
LRU	- Least Recently Used
MMU	-Memory Management Unit
MR	- Miss Rate
NDP	- Number of Distinct Pages
NPF	- Number of Page Fault
OS	-Operating System
PPF	- Page Fault Frequency
TNPR	-Total Number of Pages Referenced

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