

Distributed Selfish Caching

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<http://csr.bu.edu/dsc>

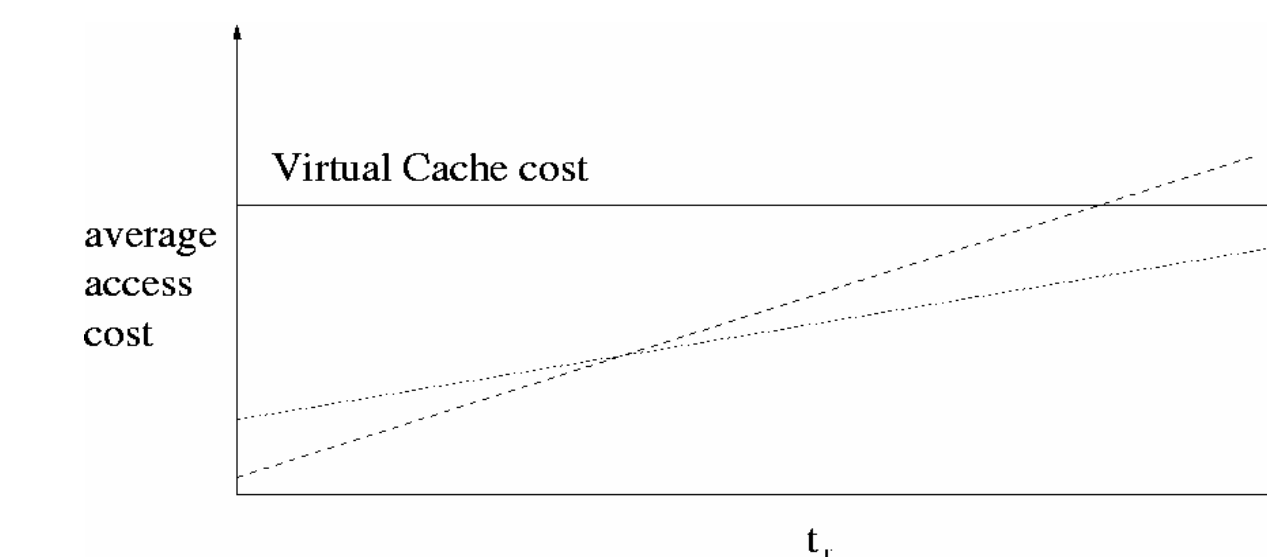
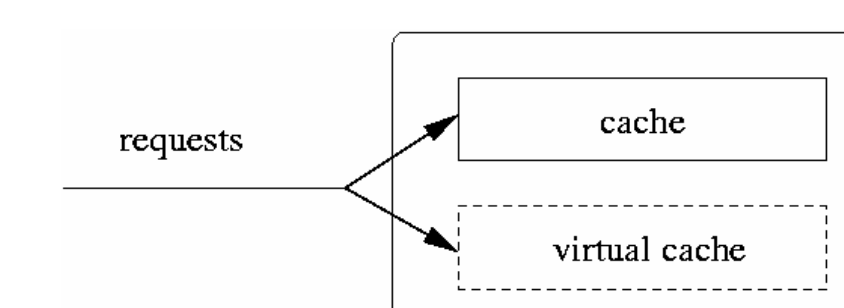
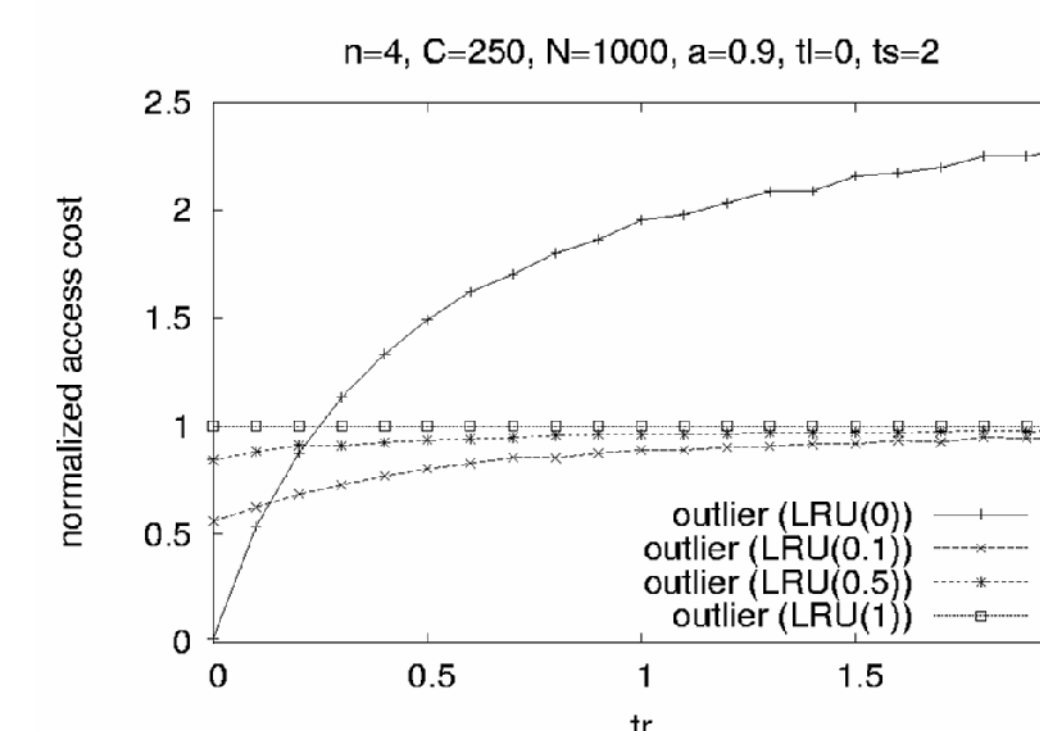


Overview

Although cooperation generally increases the amount of resources available to a community of nodes, thus improving individual and collective performance, it also allows for the appearance of potential mistreatment problems (*i.e.*, a node's access cost for fetching information objects becoming worse with cooperation than without) through the exposition of one node's resources to others. We study such concerns by considering a group of independent, rational, self-aware nodes that cooperate using on-line caching algorithms, where the exposed resource is the storage at each node. Motivated by content networking applications -- including web caching, CDNs, and P2P -- in this project we extend previous work on the on-line version of the problem [4], which was conducted under a game-theoretic framework, and limited to object replication.

Towards Mistreatment-Resilient Caching

Our solution: A virtual Cache and an Adaptive Caching Scheme



Algorithm 1: mitigation of mistreatment

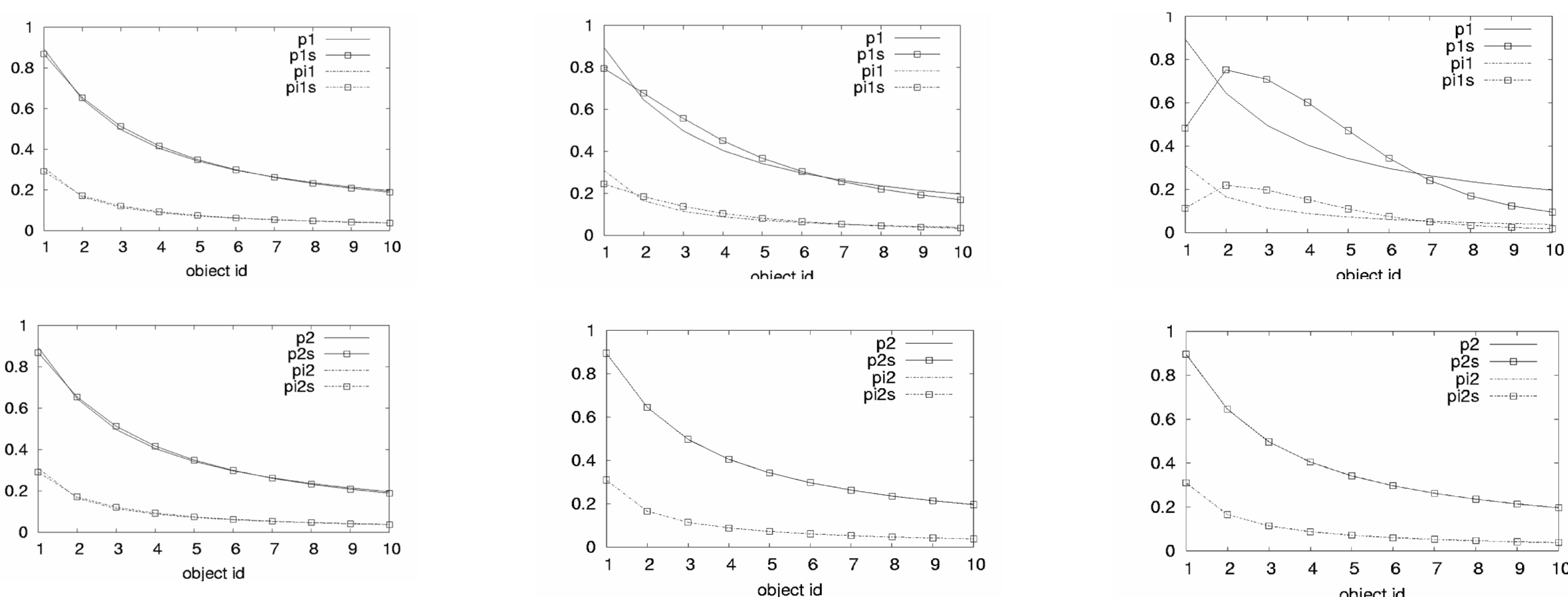
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dist(t) = cost_virtual(t) - cost_q(t)
dist(t-1) = cost_virtual(t-1) - cost_q(t-1)
diff(t) = dist(t) - dist(t-1)
sigma = sign(diff(t))
if q(t-1) >= q(t-2) then
  q(t) <- q(t-1) + sigma * alpha_c * |diff(t)| + sigma * beta_c * |diff(t)| - |diff(t-1)|
else
  q(t) <- q(t-1) - sigma * alpha_c * |diff(t)| - sigma * beta_c * |diff(t)| - |diff(t-1)|

```

Mistreatment in Distributed Caching Groups

1. Cache state Interactions due to the cooperative servicing of requests



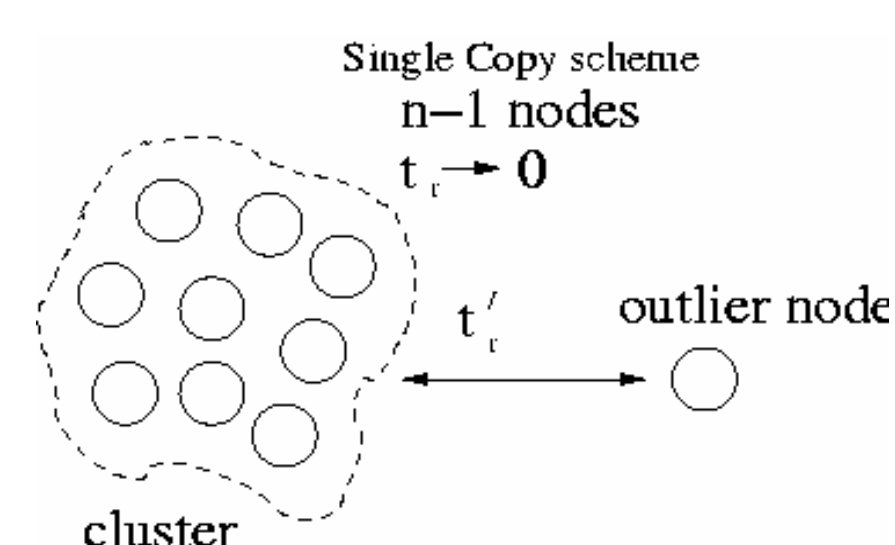
$r_4 / r_1 = 1$

$r_4 / r_1 = 10$

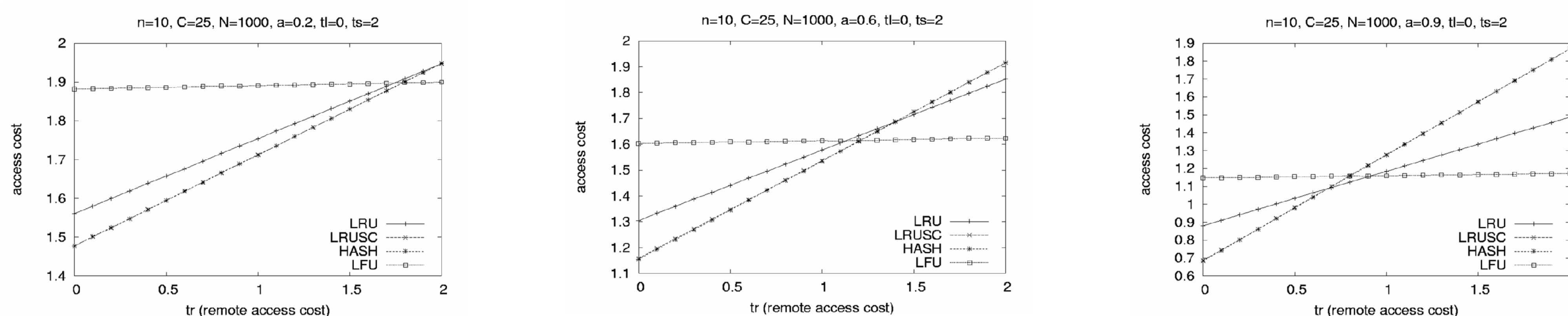
$r_4 / r_1 = 100$

2. The adoption of a Common Scheme for cache management policies

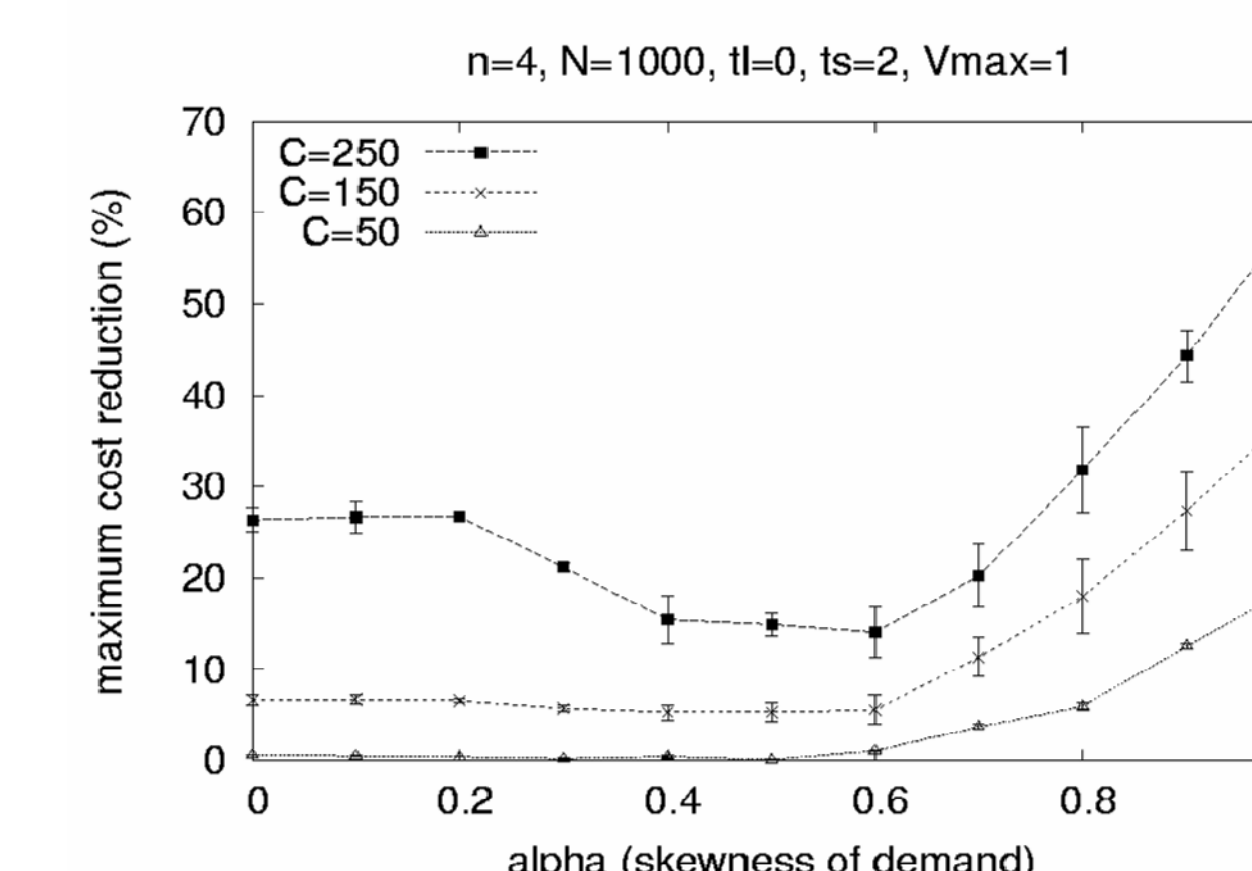
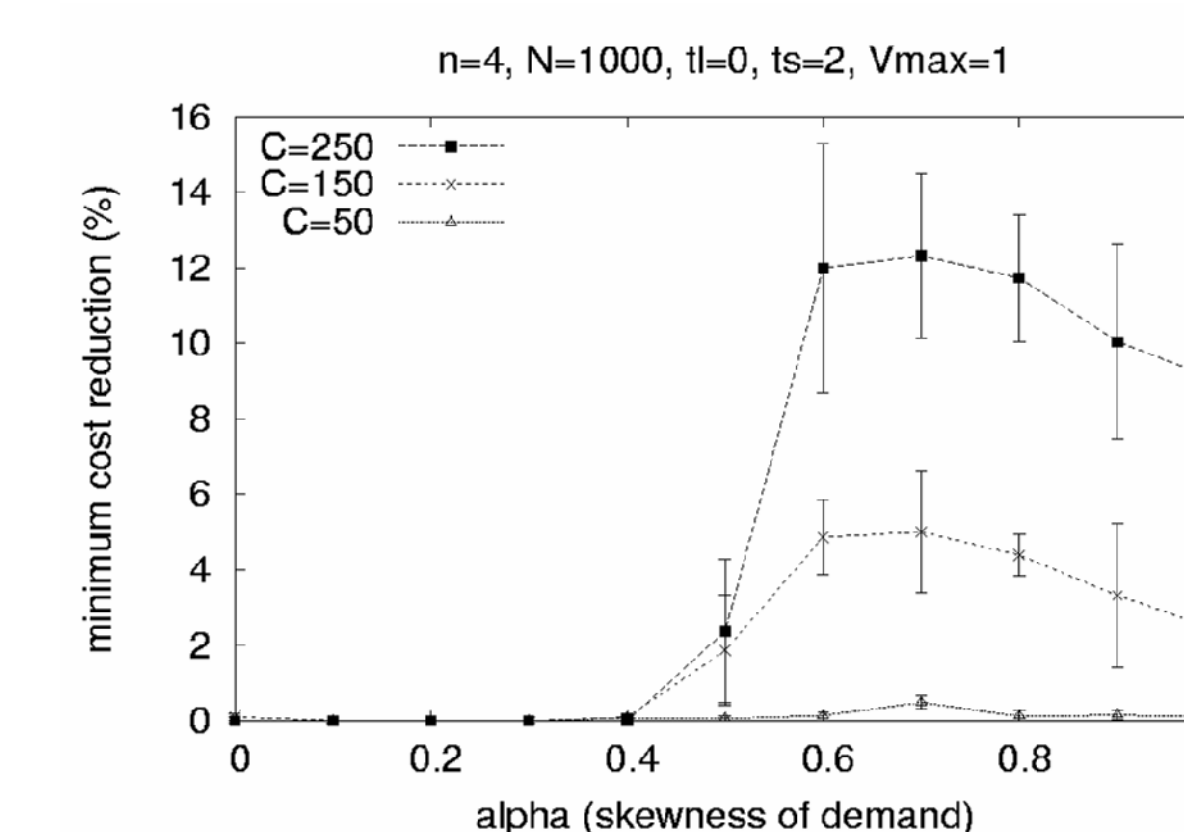
Scenario: An outlier



Mistreatment under Single Copy and Multiple Copy Schemes:



Simulation Results:



Publications:

- [1] "Mistreatment in Distributed Caching Groups: Causes and Implications" Nikolaos Laoutaris, Georgios Smaragdakis, Azer Bestavros and Ioannis Stavrakakis. IEEE INFOCOM 2006.
- [2] "A Feedback Control Approach to Mitigating Mistreatment in Distributed Caching Groups" Georgios Smaragdakis, Nikolaos Laoutaris, Ibrahim Matta, Azer Bestavros and Ioannis Stavrakakis. IFIP Networking 2006.
- [3] "Distributed Selfish Caching" Nikolaos Laoutaris, Georgios Smaragdakis, Azer Bestavros, Ibrahim Matta and Ioannis Stavrakakis. BUCS-TR-2006-003. Submitted for Journal publication.

References:

- [4] "Distributed Selfish Replication" Nikolaos Laoutaris, Orestis Telelis, Vassilios Zissimopoulos and Ioannis Stavrakakis. To appear in IEEE Transactions on Parallel and Distributed Systems, 2006.