

# Adaptive Page Allocation: Cost and Replication Analysis

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## Abstract

We analyze the performance of the COUNT replication algorithm under varying write probabilities  $p$  and replication thresholds  $D$ . We measure two primary metrics: the average cost per request and the average maximum number of replicas. Results are presented via line plots and heatmaps to illustrate trends and trade-offs.

## 1 Introduction

In distributed shared memory systems, dynamic replication can reduce read and write costs by adaptively placing copies of data. The *COUNT* algorithm tracks writes per node and replicates once a threshold  $D$  is exceeded. We evaluate how write intensity  $p$  and threshold  $D$  affect:

1. the average cost per request,
2. the maximum number of replicas observed during execution.

## 2 Methodology

We simulate a 64-node fully connected network. For each  $(D, p)$  pair, we run 10,000 independent simulations of 65,536 requests, randomly drawn from a uniform distribution over nodes. Each request is:

- a **write** with probability  $p$ ,
- a **read** with probability  $1 - p$ .

### Costs:

- **Read:** Cost is 0 if a local replica exists; 1 otherwise.
- **Write:** Cost is number of replicas if the page is not replicated, or one less if it is.
- **Replication:** When local counter reaches  $D$ , a copy is placed at cost  $D$ . Counter resets.
- **Decay/Eviction:** Counters decay on writes to other pages; replicas may be evicted if counters drop to 0.

The experiment is implemented in Rust using multithreading (via Rayon) and randomness (via `rand`). Data are exported to CSV and visualized via heatmaps and line plots.

### 3 Results

#### 3.1 Average Cost per Request

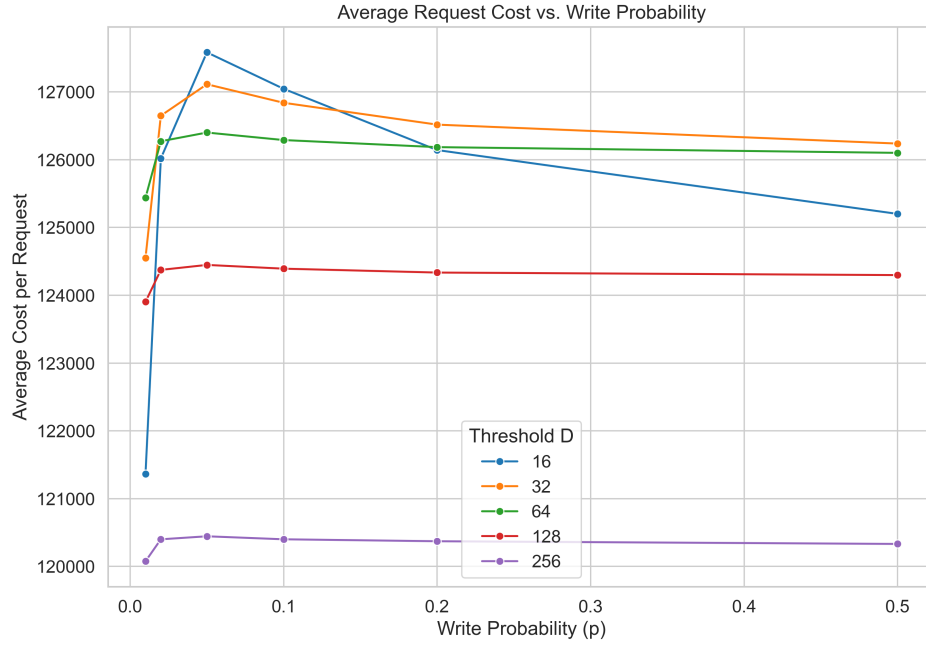


Figure 1: Average request cost vs. write probability  $p$  for various thresholds  $D$ .

#### 3.2 Average Maximum Number of Replicas

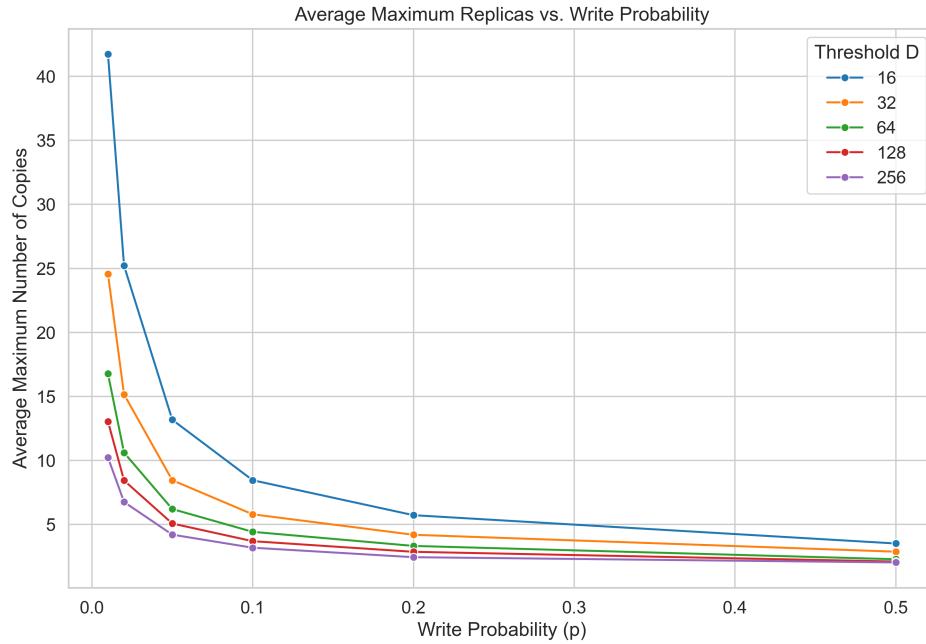


Figure 2: Average maximum number of replicas vs. write probability  $p$ .

### 3.3 Heatmap of Average Cost

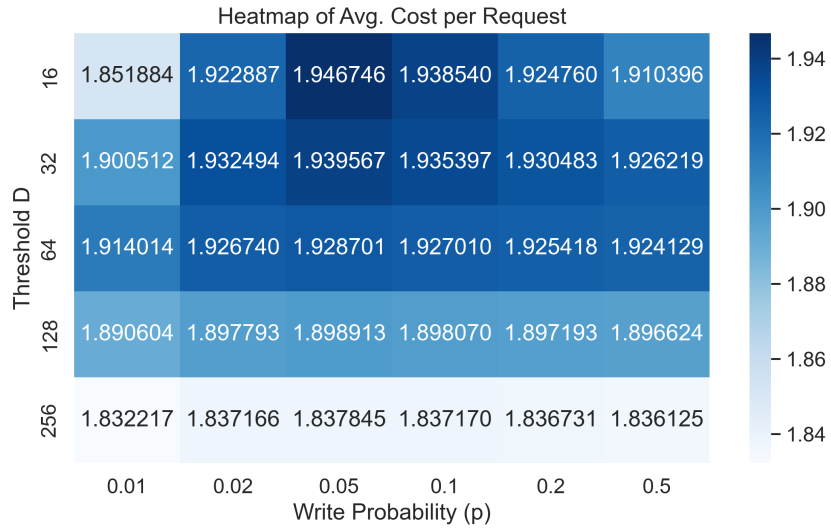


Figure 3: Heatmap showing average cost per request across thresholds  $D$  and write probabilities  $p$ .

### 3.4 Heatmap of Average Max Copies

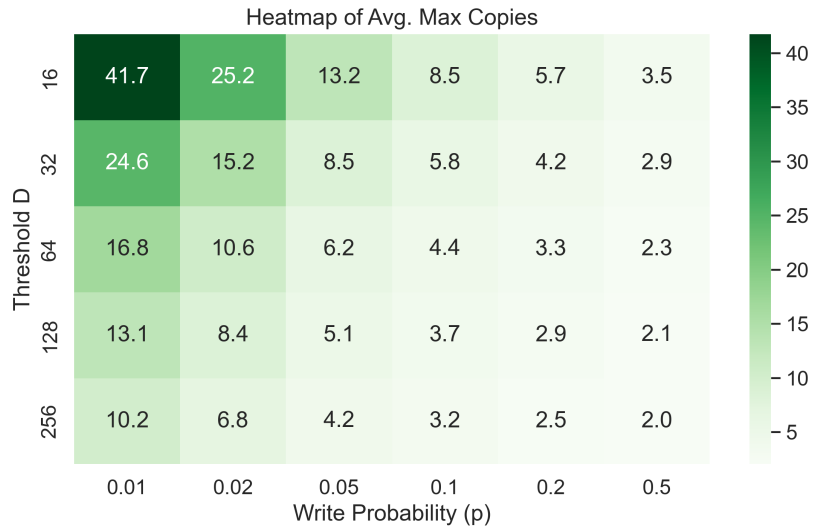


Figure 4: Heatmap showing average maximum replication degree as function of  $D$  and  $p$ .