CS622A

Advanced Computer Architecture

Assignment 2

Memory Reuse and Sharing Profile Analysis

GROUP 16

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1 Introduction

In this assignment, we use PIN tool to instrument a set of parallel programs and collect thread-wise memory access trace and break it down to x86 machine accesses. Then with the resulting trace, we analyze the sharing profile and memory reuse for the given parallel programs.

2 Analysis Results

PART 1: Collection of machine-access traces

The results were varying across individual runs. Hence, we have collected 5 results for a particular program and picked *addrtrace.out* corresponding to the middle value (highlighted).

Programs	**Run 1**	**Run 2**	**Run 3**	**Run 4**	**Run 5**
prog1.c	**128988038**	128988149	128987956	128988046	128987901
prog2.c	2528955	2513452	2521172	**2524574**	2532314
prog3.c	**9508261**	9510696	9501049	9497081	9521463
prog4.c	1061544	1061507	1061492	1061525	**1061515**

Table 1: Machine accesses count across 5 runs

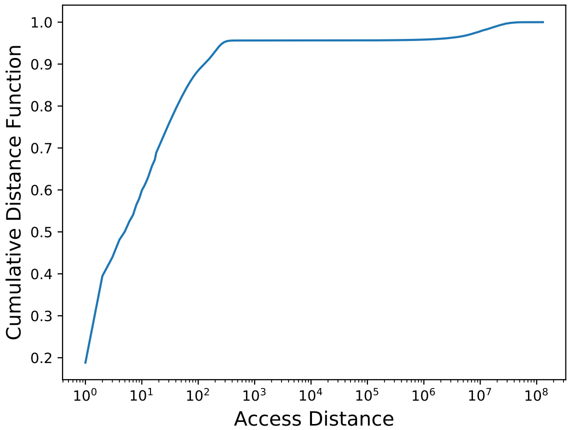
PART 4: Sharing profile analysis

The sharing profile for each of the 4 target programs is given below. The trace corresponding to the highlighted values in part1 were selected for the result analysis.

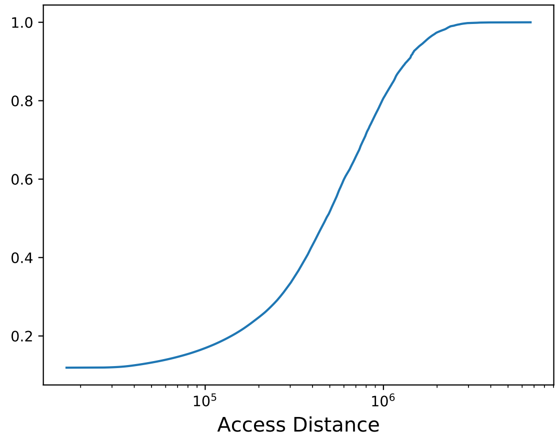
	prog1.c	**prog2.c**	**prog3.c**	**prog4.c**
Private	388	384	386	8573
2-Shared	63	8255	56	57403
3-Shared	1872	16384	0	6
4-Shared	32456	40958	1	0
5-Shared	143251	5	1	0
6-Shared	244970	0	0	0
7-Shared	173831	0	0	1
8-Shared	124527	9	65545	10

Table 2: Sharing profile analyis for 8 threads

PART 2 and 3: Access distance analysis (Normal vs Cache)

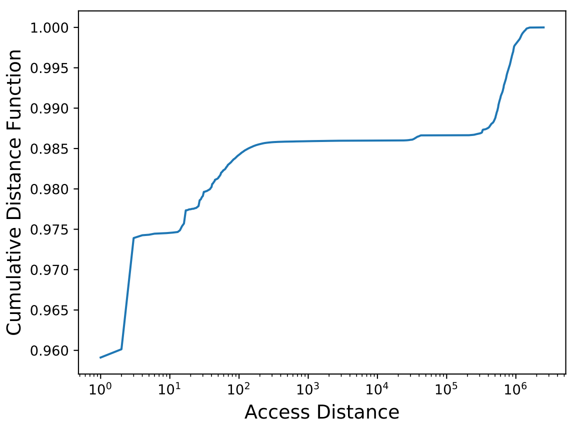


(a) Part2: CDF of access distance for prog1.c

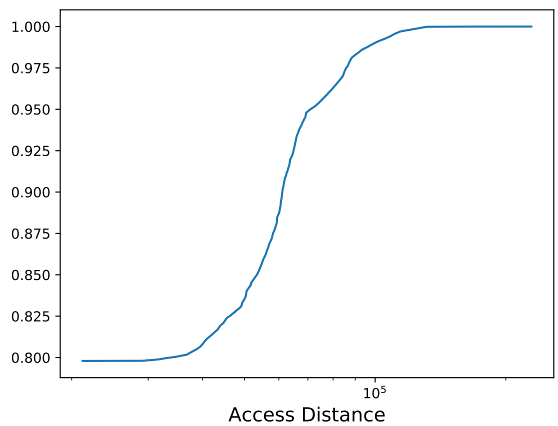


(b) Part3: CDF of access distance for misses of prog1.c

Figure 1: A comparison between the complete machine access trace and missed machine access trace for **prog1.c**

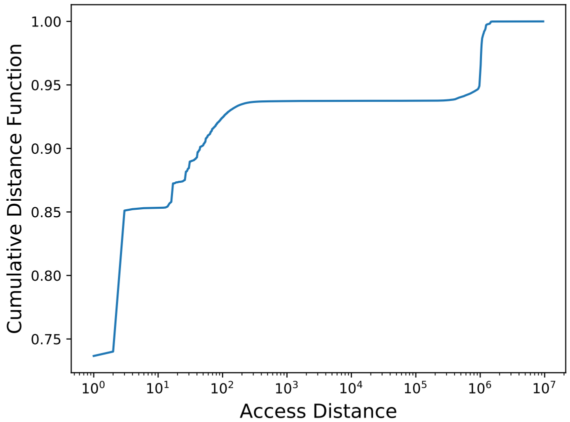


(a) Part2: CDF of access distance for prog2.c

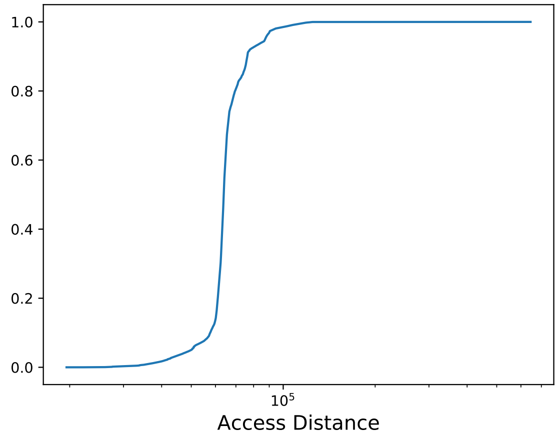


(b) Part3: CDF of access distance for misses of prog2.c

Figure 2: A comparison between the complete machine access trace and missed machine access trace for **prog2.c**

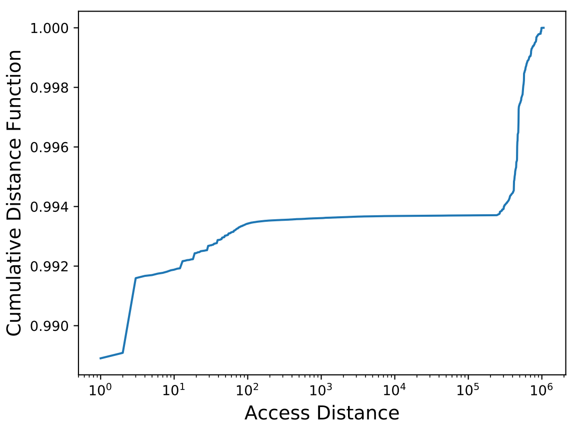


(a) Part2: CDF of access distance for prog3.c

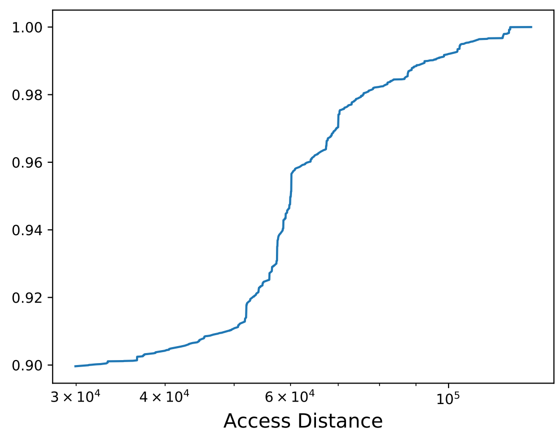


(b) Part3: CDF of access distance for misses of prog3.c

Figure 3: A comparison between the complete machine access trace and missed machine access trace for **prog3.c**



(a) Part2: CDF of access distance for prog4.c



(b) Part3: CDF of access distance for misses of prog4.c

Figure 4: A comparison between the complete machine access trace and missed machine access trace for **prog4.c**

PART 3: Hits and Misses

The cumulative distribution function for part-3 is counted specifically against the misses after modelling the single-level cache to the obtained traces.

	prog1.c	**prog2.c**	**prog3.c**	**prog4.c**
Hits	122297455	2295505	8862896	930888
Misses	6690582	229068	645364	130626

Table 3: Result of modelling a 2MB 16-Way Cache on the traces

3 Comparison of the plots

The obtained plots of cumulative distribution function of access distances for *prog{1, 2, 3, 4}.c* show subtle yet noticeable differences when taken the original trace and after modelling through 2MB 16-way single level cache and focussing only on miss traces.

1. The cdf-plots for original trace have uneven slope while the cdf-plots for miss traces shows a proper *sigmoidal* curve, which is generally seen for *(Gaussian) Normal distribution*. This implies even if the program has uneven access pattern, the hit/miss pattern solely depends on cache specifications and is more-or-less similar for any program, on a given trace.

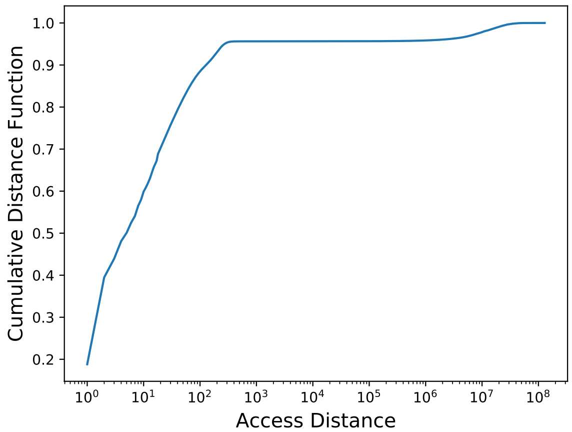
2. The initial slope of cdf-plot for miss trace is *zero* and increase gradually. While for the original plots, there is a sudden increase initially which evens out in the end. This can be explained due to *temporal locality* of accesses, where programs access nearby elements quickly in a short duration which results in high number of low-access-distance patterns.

3. The slope for cdf-plots of miss traces starts out at *zero* because it is expected that for a reasonable cache specification, low-access-distance for a block will generally result in a hit. That is, misses will be observed for blocks with high-access-distance as the block might get evicted, following the eviction policies like LRU.

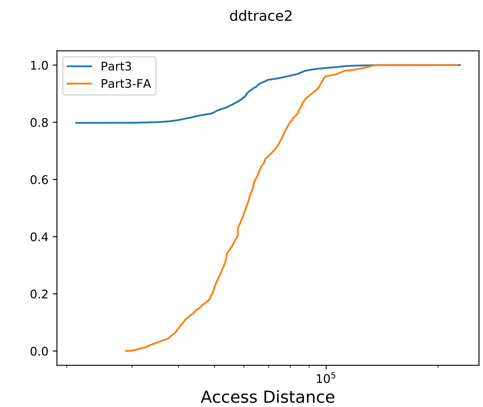
4. The cdf-plot for miss traces show a sudden jump midway (observed in Gaussian curves). This can be attributed to the fact that there is a certain limit (e.g 6×10^4) beyond which the cache capacity is exceeded and we see a large number of misses. This lets us know about the critical access distance of the blocks and that accesses below it have a greater chance of registering a hit.

4 Appendix

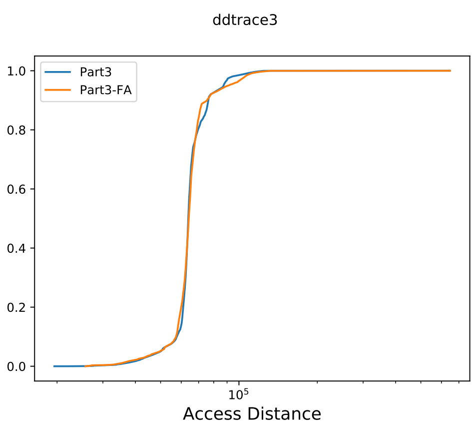
4.1 Plot contrast against Fully-Associative Cache (Part3)



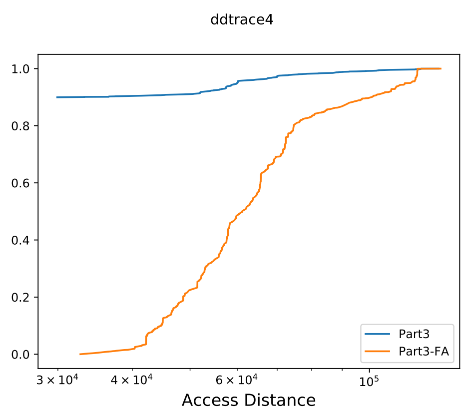
(a) CDF of access distance for misses of prog1.c



(b) CDF of access distance for misses of prog2.c



(c) CDF of access distance for misses of prog3.c



(d) CDF of access distance for misses of prog4.c

Figure 5: A comparison between the cdf-plots for miss traces with 16-way and Fully associative cache