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For Project 2, we developed an application that simulated the effect of cache on memory access. The behavior of typical CPU cache is significantly influenced by several cache attributes including cache size, block size, and associativity. We ran two different tests containing sets of instructions that exhibited varying degrees of locality. We ran each test under 16 scenarios (combinations of cache size, block size, and associativity) to display the influence of cache attributes.

For Test 1, the influence of each cache attribute was evident. The percentage of memory accesses that resulted in cache hits appeared to be positively influenced by higher cache size and block size. The positive influence of cache size on hit percentage is likely due to the fact that elements of memory have more potential places to map to, and therefore are less likely to be swapped out of cache when a new element of memory is inserted into cache (conflict miss). Higher block size likely increased hit percentage because when an element is brought into cache, one of its neighbors is also brought along. We know that data adjacent to recently referenced data is more likely to be referenced (spatial locality), so the presence of these neighbor data elements in cache probably increased the odds of a hit. For Test 1, increasing associativity also appeared to modestly improve hit rate. This is expected behavior as associativity reduces the number of conflict misses by allowing otherwise conflicting blocks to “share” the same index in cache.

A comparison of **Test 1** Hit Percentages for various

combinations of Associativity, Block Size, and Cache Size

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Associativity** | **Block  Size** | **Cache Size** | | | |
| 4 | 8 | 12 | 16 |
| One-Way | 1 | 53.1% | 53.1% | 70.5% | 70.5% |
| One-Way | 2 | 53.1% | 88.4% | 88.4% | 88.4% |
| Two-Way | 1 | 57.5% | 61.4% | 70.5% | 84.5% |
| Two-Way | 2 | 60.9% | 85.5% | 86.4% | 88.4% |

From the results of Test 2, it does appear that the influence of the various cache attributes is consistent with Test 1. However, the influence appears weaker, in part due to the fact that hit rate was relatively high in most Test 2 scenarios. It is worth noting that the hit rate in Test 1 was depressed by the high number of loads at the beginning of the program.

A comparison of **Test 2** Hit Percentages for various

combinations of Associativity, Block Size, and Cache Size

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Associativity** | **Block  Size** | **Cache Size** | | | |
| 4 | 8 | 12 | 16 |
| One-Way | 1 | 74.4% | 74.4% | 90.6% | 74.4% |
| One-Way | 2 | 75.2% | 75.2% | 91.4% | 91.4% |
| Two-Way | 1 | 64.1% | 82.1% | 90.6% | 87.2% |
| Two-Way | 2 | 91.5% | 88.9% | 82.1% | 91.5% |