

Laboratory Exercise 12

Cache Memory

Goals

After this laboratory exercise, students need to understand the basic principles of a cache memory. Furthermore, students need to know how different parameters of a cache memory can affect the efficiency of a computer system.

Literature

■ Patterson and Hennessy: Chapter 7.1–7.3

Assignments at Home and at Lab

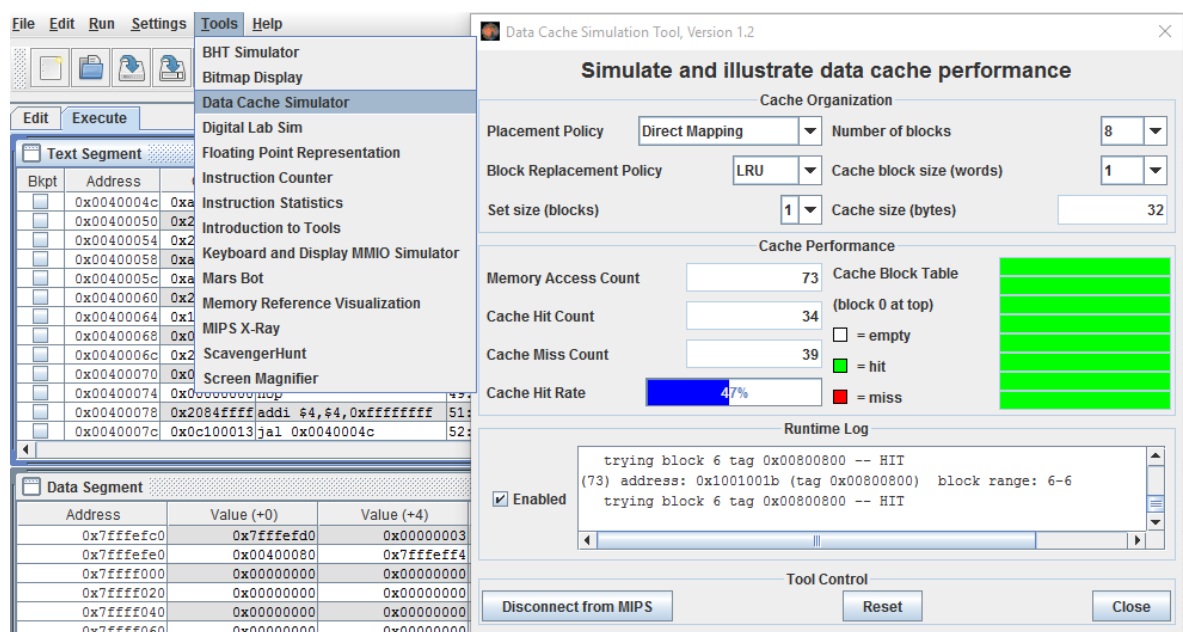
Home Assignment 1

Looking for and read documents about cache memory.

Home Assignment 2

Learn how to use the Data Cache Simulation Tool in MARS.

Understand the terms and how to configure the parameters of a cache memory.



Function of a Cache Memory

A cache memory is a memory that is smaller but faster than the main memory. Due to the locality of memory references, the use of a cache memory can have a good impact on the performance of a computer system. Indeed, the computer system can exploit both the speed of the cache memory and the size of the main memory.

Cache Efficiency

The efficiency gained by using a cache memory depends on cache size, block size, other cache parameters, and the executed program and its data structures as well.

Assignment 1

Run the Sample Code 1 and Sample Code 2 in the MARS which is connected to the Cache Simulator to observe the cache performance.

Assignment 2

After running the programs in Assignment 1, explain how the cache memory works. Then, give *full* answers to the following questions:

- How is the 32-bit address used in the cache memory?
- What happens when there is a cache miss?
- What happens when there is a cache hit?
- What is the block size?
- What is the function of the tag?

Assignment 3

Run the programs in Assignment 1 with different cache parameters to evaluate the effects of these parameters on the cache performance.

- Explain how each following parameter affects the cache performance.
 - Cache size, block size, number of sets, write policy and replacement policy.
- If a cache memory is so large that all the code of a loop fits into the cache memory, how many cache misses will occur during the execution of the loop? Is this good or bad?
- What should a code (i.e. program) look like to get the most benefit of a large block size?

Questions

Think about the questions below:

- What is the general idea of cache memory?
- What is a block?
- How does the block size affect the efficiency of a cache?
- How fast is a cache memory? How fast is a DRAM (or main memory)?
- Do the optimal cache parameters depend on the program code?
- How can one select good cache parameters?
- Is it possible to change cache size on a PC or on a Mac?