TDTS08: Advanced Computer Architecture

Lesson

2015

Linköping University
expanding reality

Outline

- Lab organization and goals
- SimpleScalar architecture and tools
- Assignment on multiprocessor systems
- Exercises

Organization

- Assistants
  - Group A: Arian Maghazeh
  - Group B: Ke Jiang
- Web page
  - http://www.ida.liu.se/~TDTS08
  - Check the lab pages!

Organization

- Sign up in Webreg
- Deadline for the assignments:

Lab 1 and Lab 2	November 26th, 2015
Lab 3 and Lab 4	December 18th, 2015
Lab 5	January 9th, 2016

- Rules: Read them! (linked from the lab pages)

Examination

- Written report for each lab
  - Hand in the report enclosed in a lab cover; it must be signed by both group members
    - Hand in at a lab session
    - Put in the box outside your assistant's office
  - Returned in the box outside your assistant's office if got a fail

Labs

- 5 labs
  - 1. Cache memories
  - 2. Pipelining
  - 3. Superscalar architectures
  - 4. VLIW processors
  - 5. Multiprocessor systems
- Labs homepage
  - http://www.ida.liu.se/~TDTS08/labs

Goals

- Obtain knowledge about computer organization and architectures
- Insights in various trade-offs involved in the design of a processor
- Become familiar with a set of tools necessary for evaluation of computer architectures
  - Simulation tools!

Environment

- Linux
  - Simulations are started from the command line!
  - If you are not familiar with the command line:
    - Ask Google first
    - Tutorials
    - List of basic commands
  - Make sure that you learn the basic commands in order to be able to work

Environment

- To setup
  - “ssh” the server from command line

    ssh yourname@simplescalar.ida.liu.se (at IDA)

    ssh yourname@130.236.181.146 (from home)
  - copy the lab files

    cp -r /home/TDTS08 ./

Environment

- To setup
  - add the following to your environment

    PATH=$PATH:/opt/simplescalar/simplesim-3.0

    PATH=$PATH:/opt/simplescalar/bin
  - add the following to your ~/.profile file

    export PATH=$PATH:/opt/simplescalar/simplesim-3.0

    export PATH=$PATH:/opt/simplescalar/bin

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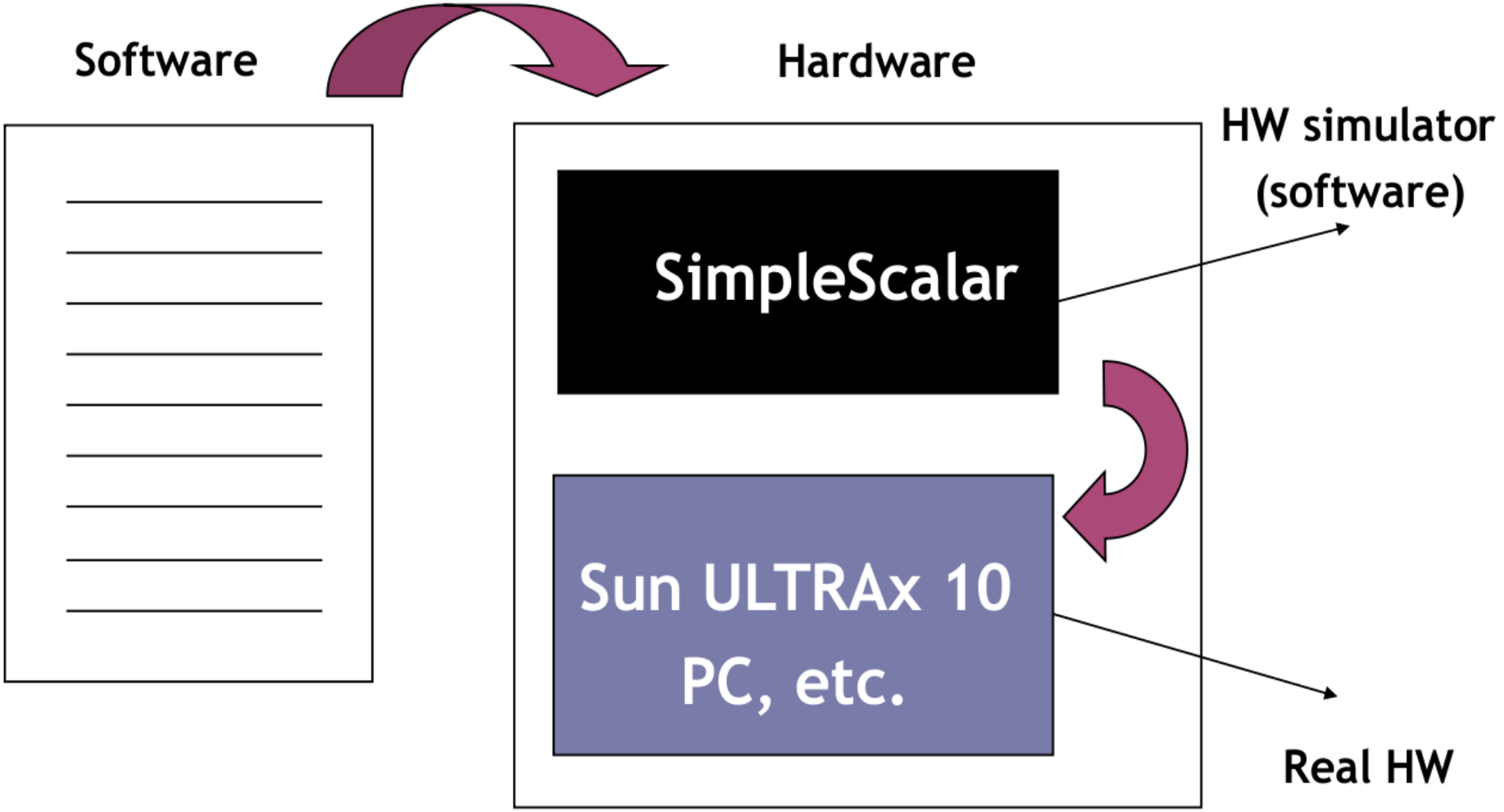
Architecture Simulation



SimpleScalar: Literature

- “The SimpleScalar Tool Set, Version 2.0” by Doug Burger and Todd M. Austin
  - Very important preparation for the labs
  - Used all the time during all labs!
- User’s and Hacker’s guide (slides by Austin)
  - Linked from the lab pages

SimpleScalar Architecture

- Virtual architecture derived from MIPS-IV
  - SimpleScalar ISA semantics are a superset of MIPS
    - Control (j, jr,..., beq, bne,...)
    - Load/Store (lb, lbu, ...)
    - Integer Arithmetic (add, addu, ...)
    - Floating Point Arithmetic (add.s, add.d, ...)
    - Miscellaneous (nop, syscall, break)

SimpleScalar Architecture (cont'd)

- Registers
  - 32 integer registers + PC, HI, LO
  - 32 floating-point registers + FCC
- Virtual memory:
  - 0x00000000 - 0x003fffff unused
  - 0x00400000 - 0x0fffffff text (code)
  - 0x10000000 - ..... data
  - ..... - 0x7fffc000 stack
  - 0x7fffc000 – 0x7fffffff Args and Env

SimpleScalar Architecture (cont'd)

- Several simulators
  - Sim-fast: Fast, only functional simulation (no timing)
  - Sim-safe: Sim-fast + memory checks
  - Sim-cache: Sim-safe + cache simulation and various timing properties (simulation time, measured time, ...)
  - Sim-cheetah: Simulation of multiple cache configurations
  - Sim-outorder: Superscalar simulator

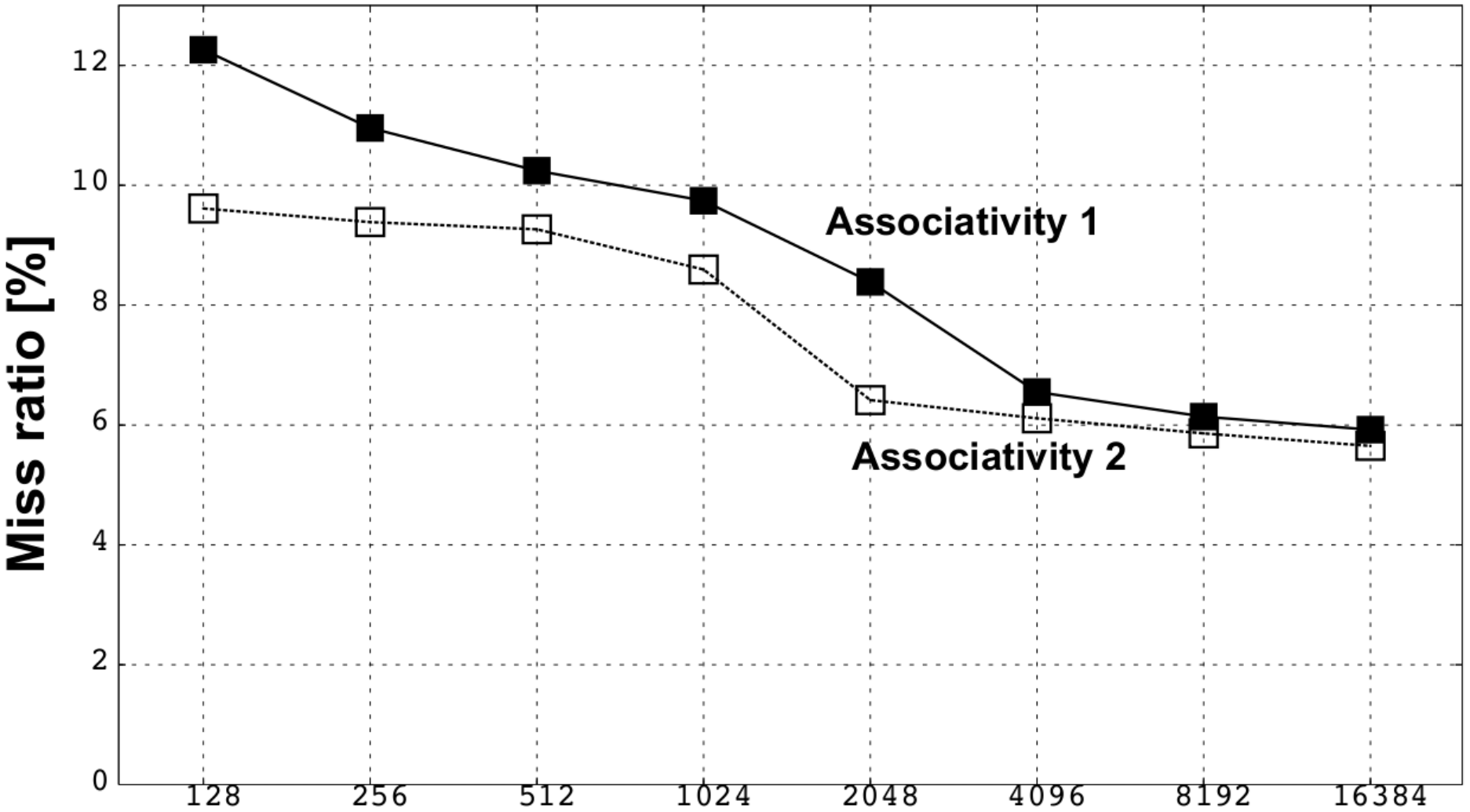
SimpleScalar Architecture (cont'd)

- The test benchmark available in ~TDTS08/bin
- Configurable through command-line arguments or files (recommended):
  - *-dumpconfig <filename>*
  - *-config <file-name>*
- gcc cross-compiler available for generating SimpleScalar binaries from your own code
  - *sslittle-na-sstrix-gcc test.c -o test*

An Example

- Lab1, assignment 3
  - Dump the default configuration of *sim-cheetah*
  - Modify the configuration and simulate
  - Plot the results (e.g. OpenOffice, Gnuplot, Matlab, Excel)

An Example


Miss ratio [%]
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4096
8192
16384
Associativity 1
Associativity 2

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Lab 5: Multiprocessor Systems

- Assignment:
  - Select an article on a multi-core, multiprocessor, multi-computer system, or a graphics processor
    - List of papers is available on the course page
    - You may select other articles if your lab assistant agrees
  - Review the selected article
  - Write a review report on the article
  - Self-learning based, no lab session allocated

Multiprocessor Systems (cont’d)

- Read and understand the paper
  - If the course literature does not help you, investigate the referenced papers.
  - Searching the Internet can help you find explanations of abbreviations and terms

Multiprocessor Systems (cont'd)

- Analyze the paper
  - Classify the architecture (e.g. MIMD, SIMD, NUMA)
  - Possible questions to ask:
    - Why has the actual method/approach been selected?
    - What are the advantages and disadvantages?
    - What is the application area?
    - What has been demonstrated?
    - ...

Multiprocessor Systems (cont’d)

- Write a report
  - ~1000 words
  - Submit, in PDF format, to your lab assistant's urkund account

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Exercises

- Review questions (page 169)
  - 4.4 and 4.8
- Problems (pages 170–172)
  - 4.8 (mandatory, Lab 1.1)
    - Include your solution in the report for Lab 1
  - Additional exercises in this order:
    - 4.15 (locality, preparation for Lab 1.2)
    - 4.22 (average memory-access time)
    - 4.17 (performance enhancement using cache)