



Universidade de Aveiro

Mestrado Integrado em Engenharia de Computadores e Telemática

Arquitectura de Computadores Avançada

Lesson 5: Branch prediction optimizations

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1. **SimpleScalar** is a set of tools that allows the simulation of PISA (Portable ISA) architecture, similar to the MIPS IV, with several degrees of detail / speed. The tool set includes, in addition to the simulators, compilers, assemblers and linkers for the simulated architecture.
 - 1.1. Compile the **SimpleScalar** tools for your system using the simplesim-3.0 package available at moodle.
 - 1.2. Run the **SimpleScalar** binary benchmarks **dhry.ss**, and **prime.ss** (simplified versions of the "dhrystone" and "prime" benchmarks used in the first lesson) using the simulator **sim-profile** with the option **-iclass**. Take note of the number of instructions executed as well as of the distribution by classes of instructions.
 - 1.3. Repeat the previous step for **dhry_opt.ss** and **prime_opt.ss** (optimized versions of "dhrystone" and "prime" benchmarks).
 - 1.4. Determine the speedup obtained through optimization (assuming the CPI is 1).
2. Use the **SimpleScalar** simulator **sim-bpred** to test several architectures of branch predictors.
 - 2.1. Run the **sim-bpred** program and check the meaning of its command line parameters. Show which parameters allow the simulation of the following predictors:
 - 2.1.1. Taken predictor. `./run-cc1.sh -bpred taken`
 - 2.1.2. Bimodal predictor with 512 entries. `./run-cc1.sh -bpred bimod -bpred:bimod 512`
 - 2.1.3. Global history predictor with a Branch History Register (BHR) of 10 bits. `./run-cc1.sh -bpred 2lev -bpred:2lev 1 1024 10 0`
 - 2.1.4. Gshare predictor with 8 bits history. `./run-cc1.sh -bpred 2lev -bpred:2lev 1 256 8 1`
 - 2.1.5. Two levels predictor with 512 entries of 10 bits in the first level and 1024 entries in the second level. `./run-cc1.sh -bpred 2lev -bpred:2lev 512 1024 10 1`
 - 2.1.6. Hybrid predictor that combines the previous predictor with a bimodal predictor of 2048 entries, using a 256 input table to select the predictor to be used.
 - 2.2. The script **run-cc1.sh**, available in package **run-cc1.tgz**, accepts the same parameters of the **sim-bpred** simulator. This script runs the simulator **sim-bred** using one benchmark of the SPEC95 package.
 - 2.2.1. Check the prediction success rates for the taken and not taken static predictors.
 - 2.2.2. Analyze the evolution of the prediction success rate of a bimodal predictor varying the number of entries between 8 and 32K.

- 2.2.3. Analyze the differences between the rates of correct prediction for "gselect" and "gshare" predictors, varying the number of entries of the 2nd level table between 8 and 32K (3 to 15 bits).
- 2.2.4. Try to find the best branch predictor configuration, between those that are possible to simulate with the **sim-bpred**, fulfilling a maximum storage bit budget of 4Kbits +10%.