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ECE552 Lab 2 Dynamic Branch Predictor Report

1. Microbenchmark

Since 6 bits history register is used and there is no destructive aliasing between the indexing PCs of the branch history table. Therefore the if statement at (0x698 of the comments in the microbenchmark's object dump) will have a 100% correct prediction in stable state as the history bits can capture all of the possible occurring patterns of a branch pattern length of 5. However, the branch pattern at if statement at line 11 (0x6c3 of the comments in the microbenchmark's object dump) has a length of 8, and a 6-bits history register is unable to capture all of the possible patterns. Specifically, the pattern is NTTTTTTT NTTTTTTT NTTTTTTT for that branch, and the 2 level predictor will mispredict if the past history is TTTTTTT as it will first predict not taken and then predict taken which are both wrong predictions. Therefore the MPKI is significantly greater than 0. If the if statement condition at line 11 of the microbenchmark is changed to i%7 == 0 then the pattern will be 7 bits long and the 6 bit history register can capture all of the patterns that will occur and thus the MPKI approaches 0.

2. Prediction Statistics

	#Mispred 2bitsat	#Mispred 2level	#Mispred openend	MPKI 2bitsat	MPKI 2level	MPKI openend
Astar	3695830	1785464	829572	24.639	11.903	5.530
Bwaves	1182969	1071909	841473	7.886	7.146	5.610
Bzip2	1224967	1297677	1200167	8.166	8.651	8.001
Gcc	3161868	2223671	810435	21.079	14.824	5.403
Gromacs	1363248	1122586	836236	9.088	7.484	5.575
Hmmer	2035080	2230774	1791811	13.567	14.872	11.945
Mcf	3657986	2024172	1542979	24.387	13.494	10.287
Soplex	1065988	1022869	826927	7.107	6.819	5.513

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3. Open-ended branch predictor

Our open-ended predictor is an variational gshare predictor. We keep tracking of 15 bits of global branch history. This history table is updated from left to right in younger to older order. We also use a 32768 entry 3-bit saturating counter table to do prediction. Its index is PC xor with global branch history and only lower 15 bits are used. Our 3-bit saturating counter table is initialized to value 3. The prediction step is to check if the value in the prediction table is greater or equal to 4. If it is greater, predict to take, else not taken. The update rule is similar to 2-bit sat. So total storage is: 32768 * 3 = 98304 bits = 12288 bytes for prediction table and 15 bits ~= 2 bytes for global history. Totally 12289 bytes.

We have tried to use longer global history but it requires a compress hash function to compress longer history bits into shorter index bits. It did not perform well comparing to 15 bits history table. We also tried to use 3 banks with different hash functions to solve index aliasing problem. But it does not perform well again comparing to pure xor global history table.

4. CACTI statistics

	Area(mm2)	Access latency(ns)	Leakage power(mW)
2level	0.0018	0.164342	0.36639
openend	0.0468	0.343503	10.3838

5. Work completed

Daiqing Li:

- Implemented open-end branch predictor and record statistics.
- Wrote a test script for calculating the averages of predictor results
- Performed CACTI simulation and recorded statistics
- Wrote the report

Yi Liu:

- Implemented the bimodal and two level predictors
- Consolidated report
- Wrote the microbenchmark