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Lab 2 Report

Microbenchmark

The microbenchmark consists of 4 branches, a for loop and three if statements. The for loop should be predicted accurately other than the initial loop and the loop exit and runs for 1000000 iterations. The first if statement consists of a 2 bit pattern, which should be predicted correctly. This should predict correctly up until a 7 bit pattern history for any pattern since it is a PAp (assuming no aliasing). The second if statement consists of a 10 bit pattern, which should predicted incorrectly and have a 1 misprediction in 10 branches. Similarly the third if statement depends on the above 2 if statements and has a 10 bit pattern history which results in a 1 misprediction per 10 branches. Therefore, for 1000000 iterations, there should be 200000 mispredictions. The number received from the predictor is 202032.

Benchmark Results

Table of Mispredictions

Predictors/ Benchmarks	astar	bwaves	bzip2	gcc	gromacs	hmmer	mcf	soplex
2bitsat	3695830	1182969	1224967	3161868	1363248	2035080	3657986	1065988
2level	1785464	1071909	1297677	2223671	1122586	2230774	2024172	1022869
openend	876164	866209	1145362	801002	851549	1939901	1607151	817655

Table of MKPI

Predictors/ Benchmarks	astar	bwaves	bzip2	gcc	gromacs	hmmer	mcf	soplex
2bitsat	24.639	7.886	8.166	21.079	9.088	13.567	24.387	7.107
2level	11.903	7.146	8.651	14.824	7.484	14.872	13.494	6.819
openend	5.841	5.775	7.636	5.340	5.677	12.933	10.714	5.451

AVG open end MKPI = 7.421

Open ended Branch Predictor

The design of the branch predictor came from the GSkew/GSelect/GShare predictor. The predictor consists of 3 predictors and a voting mechanism. The three predictors share a 15 bit global history register. This GHR is then hashed with the PC. This hashing function is different for every PHT. The first hash function is from the GSelect predictor. It xors 7 bits of the PC and 8 bits of the branch address. The second hash function is from the cantor pairing formula in hopes of generating 1 unique number from 2 numbers. The last hash function xors the two previous indices.

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Each table stores the same branch information and the only difference is that they are indexed differently. Each PHT also has 2 bits for hysteresis. The prediction is then taken from the majority vote of the predictors. This is to avoid aliasing. Aliasing can occur in one table, but hopefully the other 2 tables avoid it. The downside of this is that there are 3 tables that contain the same information and is therefore very storage reliant.

Storage calculation:
History: 15bit, Tables: 3, Entries: 21330, Bit/entry: 2
Total: 15 + 3 * 2 * 21330 = 127,995 bit

CACTI Configuration:
For the simulation of the 2 level predictor and the open ended predictor, the pure RAM configuration file was used. The 2 level predictor was split into two structures. Ideally, the open ended predictor PHTs are accessed in parallel. In the worse case scenario, they would be accessed in series. Both the best and worst case scenarios are provided in the results section.

2 Level Predictor	Size (Bytes)	Block (Bytes)	I/O (bits)
First Level	8196/8 = 1024	1	8
Second Level	2^6 / 8 = 128	1	8

Open Ended	Size (Bytes)	Block (Bytes)	I/O (bits)
First Predictor	2^15 / 8 = 8192	1	8
Second Predictor	2^15 / 8 = 8192	1	8
Third Predictor	2^15 / 8 = 8192	1	8

CACTI Results:

Predictor	Access latency (ns)	Power leakage (mW)	Area (mm^2)
2 Level	0.164 + 0.144 = 0.307	0.366 + 0.054 = 0.420	0.0019 + 0.0003 = 0.0022
Open Ended	Best: 0.280 Worst: 0.280*3 = 0.84	2.87 * 3 = 8.62	0.0127 = 0.0381

Work Breakdown:
Zexi Pan: 2 bitsat predictor, Open-ended predictor, Microbenchmark, Report Writing
Xiaoyang Guo: 2-level predictor, Open-ended predictor, CACTI, Report Writing