NC State University

Department of Electrical and Computer Engineering

ECE 463/563: Fall 2019 (Dr. Huiyang Zhou)

Project #2: Branch Prediction

By

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NCSU Honor Pledge: "I have neither given nor received unauthorized aid on this test or assignment."

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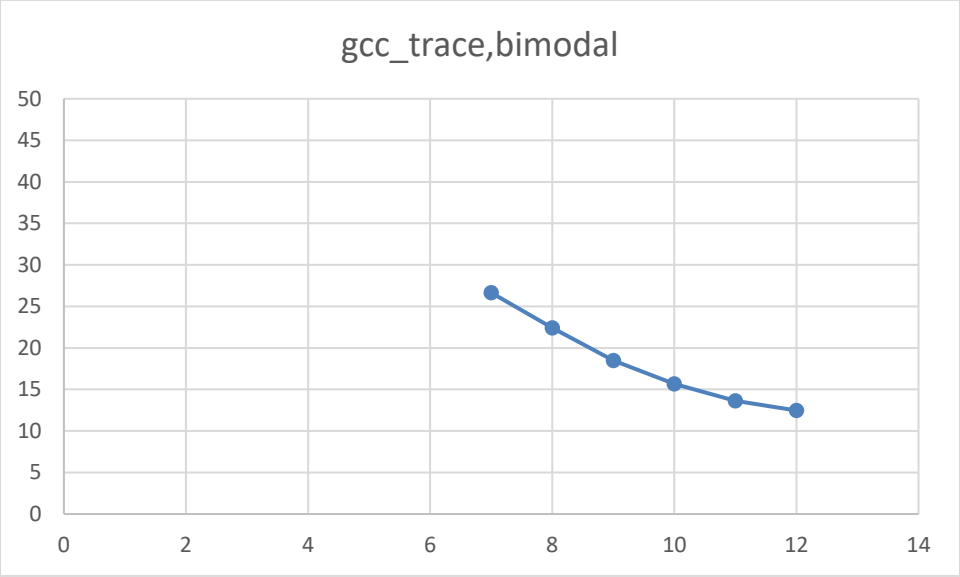
Course Number: ____563_____

Bimodal Predictor

Graphs

m	Misprediction Rate
7	26.65
8	22.43
9	18.49
10	15.67
11	13.65
12	12.47



Analysis

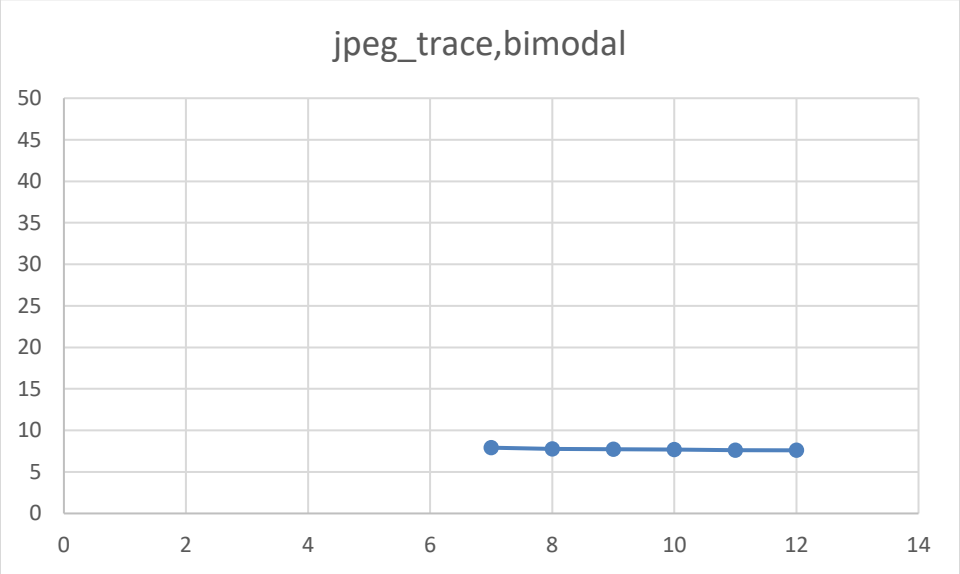
As we can see from the graph there is a significant drop in the misprediction rate as we increase the size of the bimodal table which tapers off around m=12

Design

We can minimize costs and obtain a reasonably good misprediction rate if we set m=13 as increasing the table size after that does not result in much drop in the misprediction rate.

Graphs

m	Misprediction Rate
7	7.92
8	7.79
9	7.74
10	7.7
11	7.62
12	7.6



Analysis

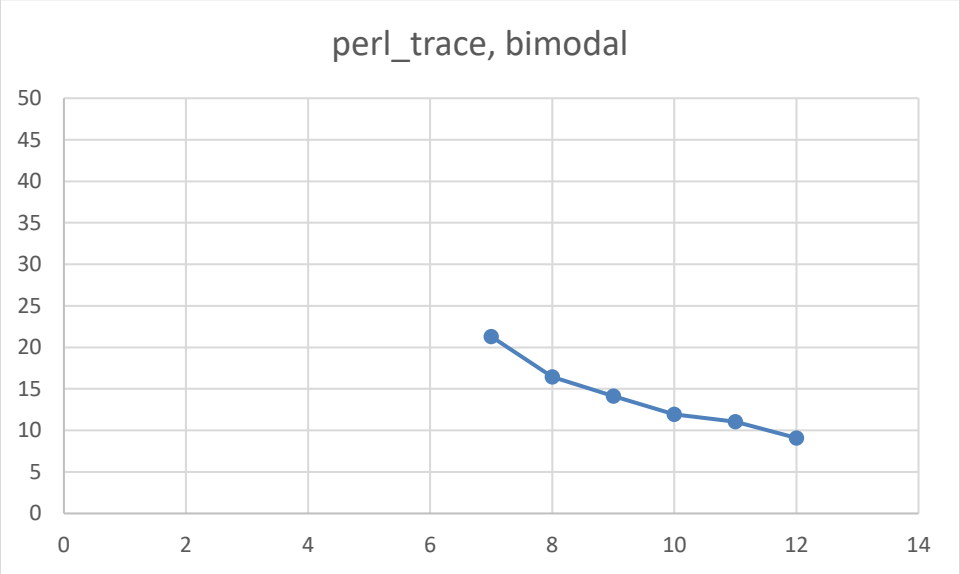
For the jpeg_trace dataset increasing the table size has no significant impact on the misprediction rate which decreases by just 0.3% when we increase the table size from 64 bits to 8192 bits.

Design

Considering the lack of improvement in the misprediction rate even though we increase the size of this dataset the ideal size would be to set the index size to m=8 taking the table size to 64 bytes.

Graphs

m	Misprediction Rate
7	21.31
8	16.45
9	14.14
10	11.95
11	11.05
12	9.09



Analysis

From the analysis of the graph and the values of m till 16 we are able to observe that the misprediction rate tapers off around m=12 at a misprediction rate of around 9%.

Design

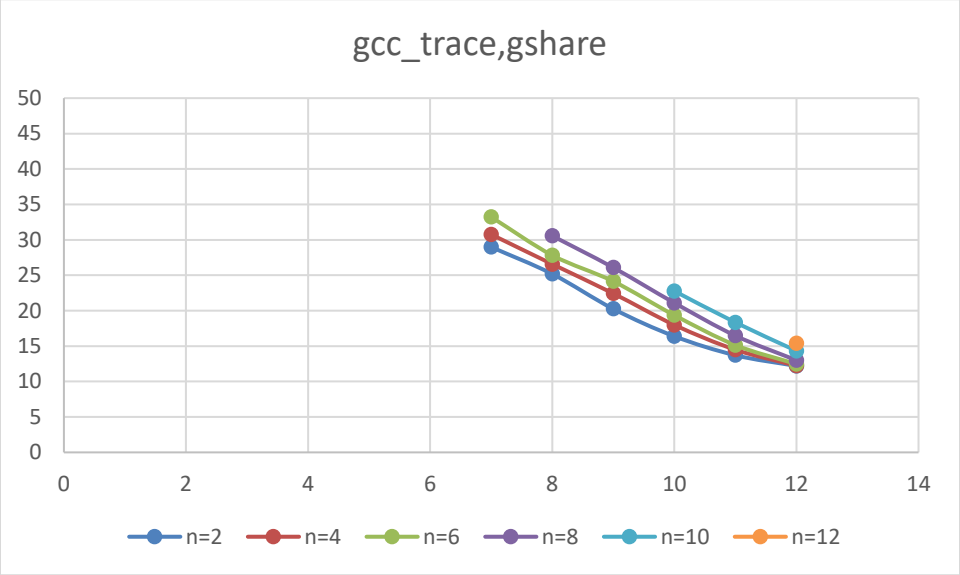
To minimize cost and maintain reasonable prediction accuracy I would set the table size to around m=12 as the subsequent gains in prediction accuracy are not proportional to the required increase in table size. The table size would then be 1KB.

Gshare Predictor

Graphs

For gcc_trace.txt

m	n=2	n=4	n=6	n=8	n=10	n=12
7	28.98	30.76	33.22			
8	25.18	26.57	27.82	30.56		
9	20.25	22.43	24.14	26.08		
10	16.39	17.99	19.36	21.1	22.77	
11	13.71	14.49	15.14	16.47	18.34	
12	12.2	12.23	12.46	13	14.33	15.4



Analysis

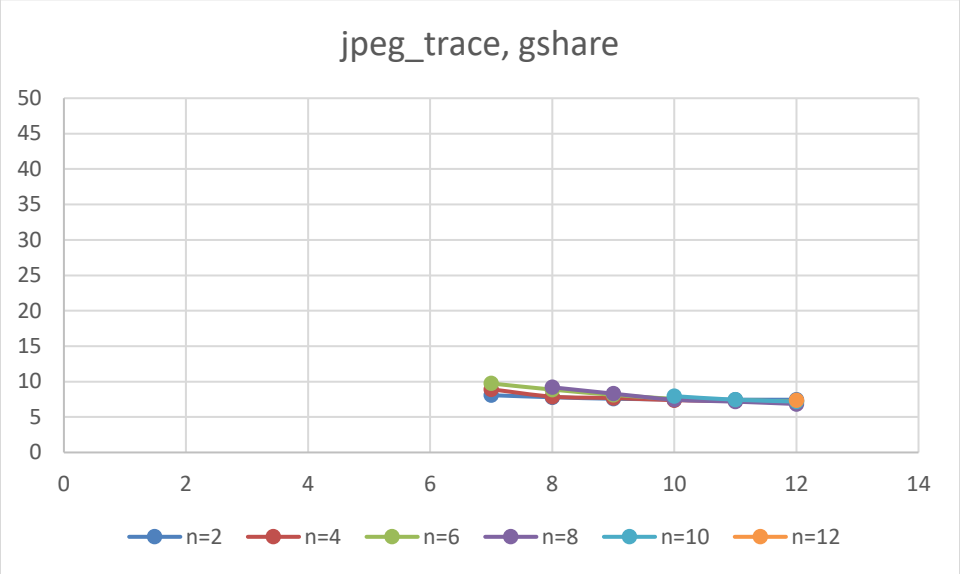
The misprediction rate drops at an almost linear rate before tapering off at around m=12 and a misprediction rate of approximately 10%. The best prediction accuracy is observed at m=16 and n=10 at 7.61%.

Design

Although the best prediction accuracy (7.61%) is observed at m=16 and n=10 which leaves the branch history table at size 16KB. We can also get a prediction accuracy of 9.83% for m=14 and n=10 with the prediction table size of 4KB which would be preferred if lowering the footprint of the BPU is a priority.

Graphs

m	n=2	n=4	n=6	n=8	n=10	n=12
7	8.08	8.92	9.74			
8	7.79	7.88	8.87	9.2		
9	7.58	7.68	8.13	8.3		
10	7.49	7.38	7.58	7.45	7.95	
11	7.45	7.27	7.38	7.17	7.44	
12	7.44	7.26	7.19	6.84	7.18	7.35



Analysis

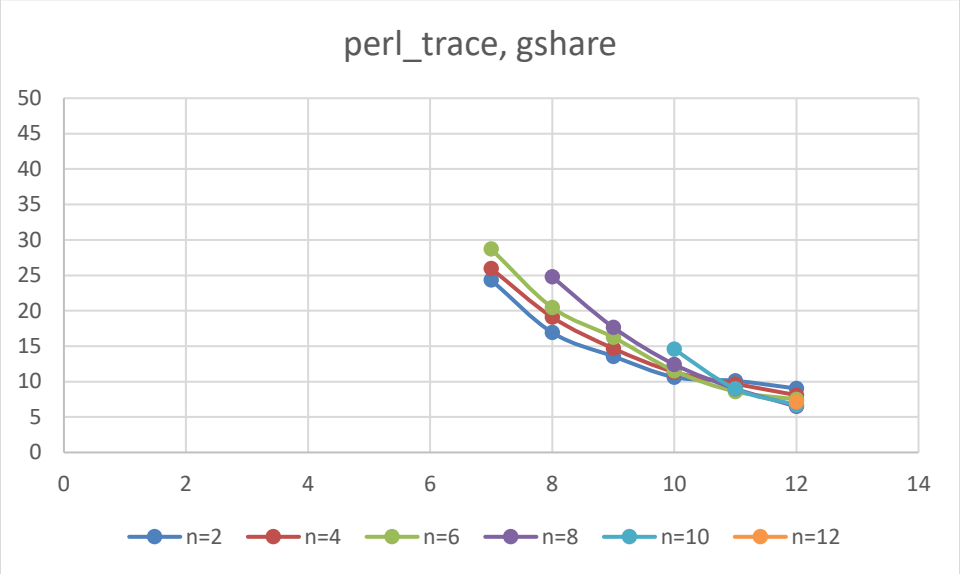
The misprediction rate for the values of m from 7 to 16 is varies from 9% to 6.66%. We saw a similar trend for the jpeg_trace dataset for the bimodal predictor as well and can be attributed to the peculiarity of the dataset with high similarity in the branches taken.

Design

Setting the value of m to 9 and the size of the BHR to n=2 should give us a misprediction rate of 7.58% which limits the size of the prediction tables to just 64 bytes while maintaining a high prediction accuracy.

Graphs

m	n=2	n=4	n=6	n=8	n=10	n=12
7	24.34	25.96	28.71			
8	16.92	19.09	20.45	24.79		
9	13.57	14.68	16.25	17.66		
10	10.63	11.35	11.52	12.42	14.57	
11	10.11	9.68	8.6	9	8.98	
12	9.03	8.09	7.5	6.49	6.71	7.16



Analysis

From the analysis of all the configurations in the 16KB budget we can see that the lowest misprediction rate was observed when m=16 and n=16 at 2.91%. We were successfully able to reduce the misprediction rate all the way from 30% to this range by taking advantage of recognizing the patterns using the BHR.

Design

Although we get the best misprediction rate at m=16, n=16 we can achieve reasonably close prediction accuracy at m=14 and n=12 at a quarter of the size and it can be an ideal tradeoff. The branch predictor table size would be 4KB.