NC State University

Department of Electrical and Computer Engineering

ECE 463/563: Fall 2017

Project #2: Branch Prediction

by

SHRINATH CHERIYANA

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Student's electronic signature: SHRINATH CHERIYANA

(sign by typing your name)

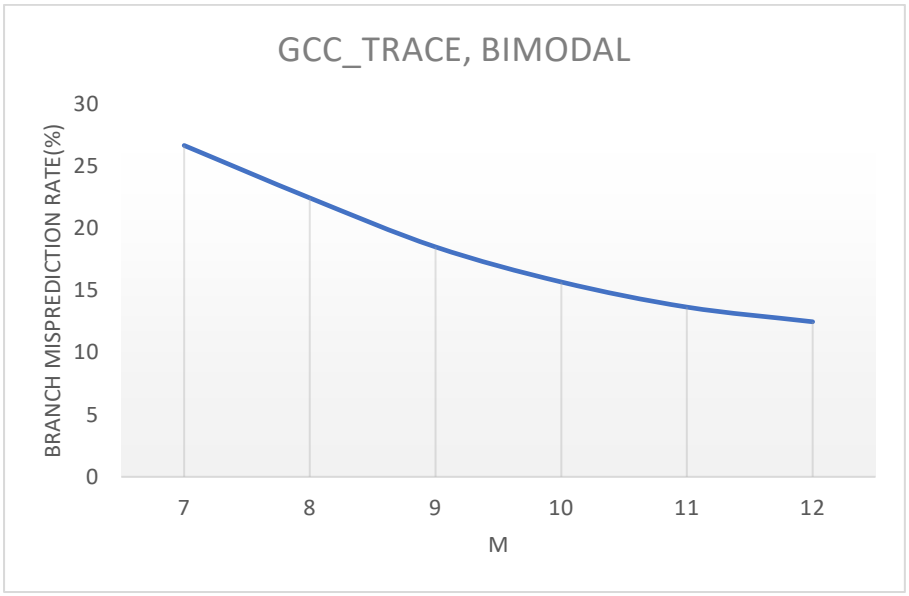
Course number: 563

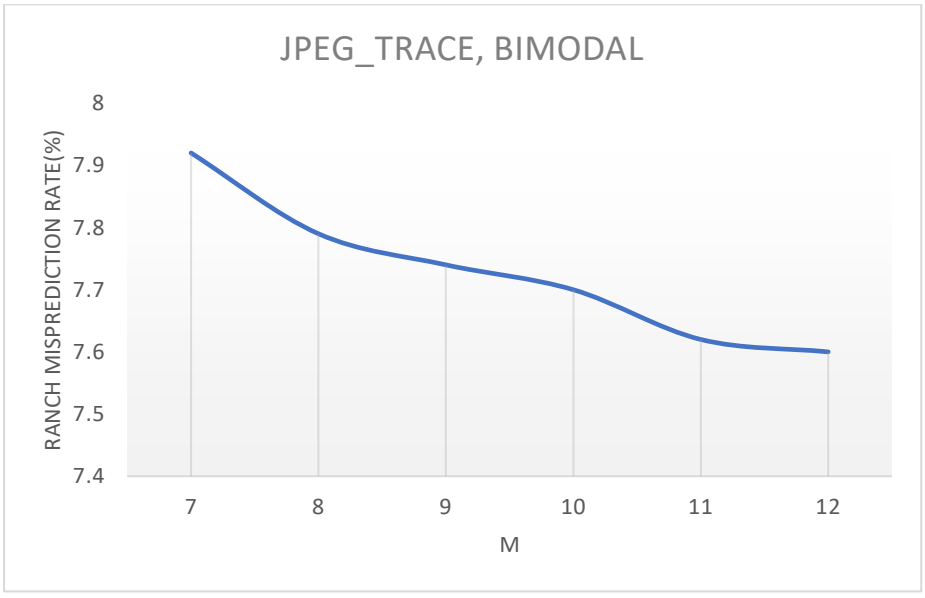
(463 or 563 ?)

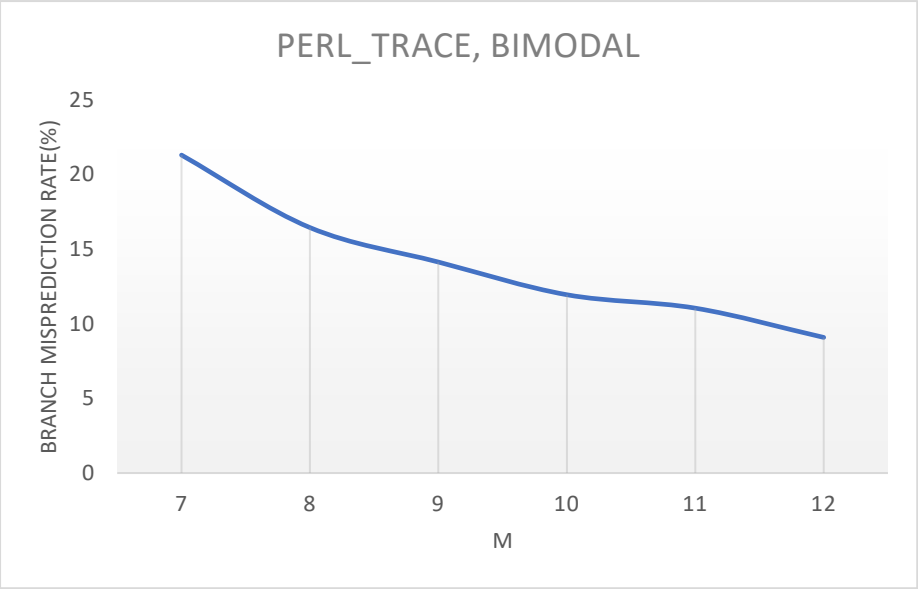
BIMODAL PREDICTOR:

1)

BIMODAL	**MISPREDICTION RATE (%)**		
M	GCC_TRACE	JPEG_TRACE	PERL_TRACE
7	26.65	7.92	21.31
8	22.43	7.79	16.45
9	18.49	7.74	14.14
10	15.67	7.7	11.95
11	13.65	7.62	11.05
12	12.47	7.6	9.09







ANALYSIS:

- As observed from the above graphs we conclude that with an increase in "m" the misprediction rate decreases.
- We know that the size of the prediction table is related to "m" as follows: Prediction Table Size = 2^m. Now as we increase "m" the size of the prediction table will increase significantly. Now as size of the prediction table increases, more number of unique branch counters can be maintained. For example, if for a given "m" two branches (one taken and other not taken) map to the same location in the prediction table, then the counter value will keep on toggling. But now if we increase the size the chances that these two branches will map to two different locations in the prediction table increases and the chances that the predicted outcome is same as the actual outcome also increases. Thus, we see a decrease in misprediction rate as we increase "m".
- All three benchmarks show decrease in the misprediction rate with increase in "m". GCC decreases uniformly, while the other two decreases non-uniformly.

2)

BIMODAL	**MISPREDICTION RATE (%)**		
M	GCC_TRACE	JPEG_TRACE	PERL_TRACE
7	26.65	7.92	21.31
8	22.43	7.79	16.45
9	18.49	7.74	14.14
10	15.67	7.7	11.95
11	13.65	7.62	11.05
12	12.47	7.6	9.09
13	11.72	7.59	8.92
14	11.37	7.59	8.82
15	11.3	7.59	8.82
16	11.21	7.59	8.83

DESIGN:

GCC TRACE: m=13, Misprediction rate=11.72

JPEG TRACE: m=11, Misprediction rate=7.62

PERL TRACE: m=12, Misprediction rate=9.09

For the above given values, we see that any increase in "m" does not significantly decrease the misprediction rate. We see that for any increase in the value of "m" beyond the above specified value the misprediction rate starts to level off and thereby the improvement in hardware only shows a minor improvement with an increase in the cost.

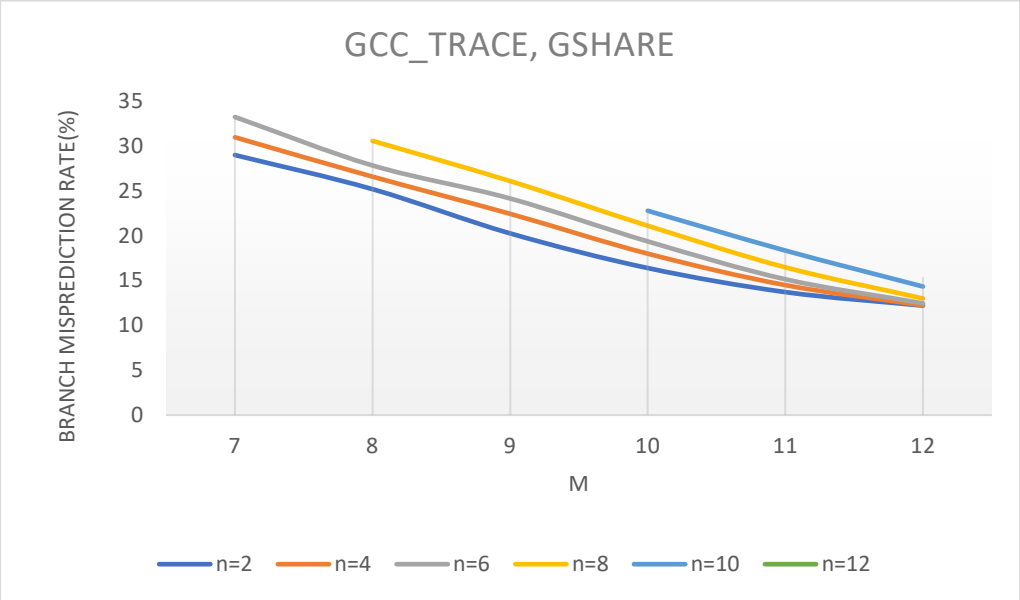
GSHARE PREDICTOR:

1)

GCC:

Table for Misprediction rate%

m/n	2	4	6	8	10	12
7	28.98	30.96	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

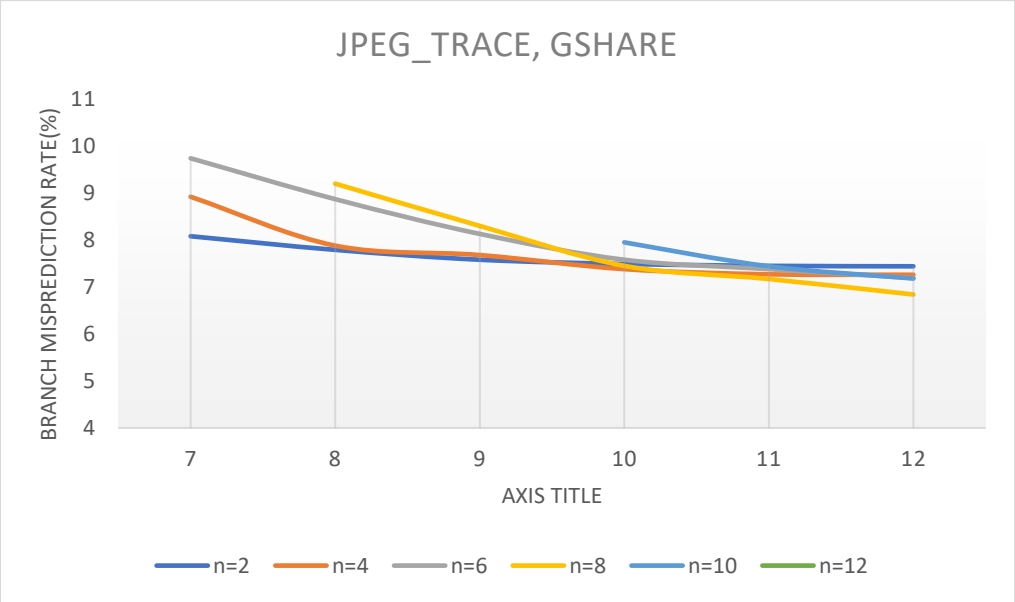


JPEG:

Table for Misprediction rate%

m/n	2	4	6	8	10	12
7	8.08	8.92	9.74			

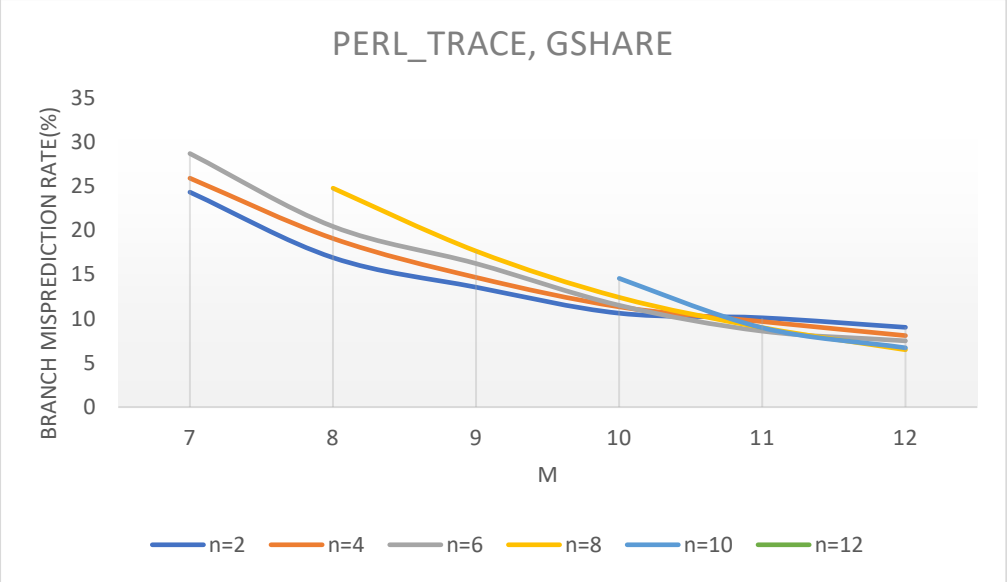
8	7.79	7.88	8.87	9.2		
9	7.58	7.68	8.13	8.3		
10	7.49	7.38	7.58	7.45	7.95	
11	7.45	7.27	7.38	7.17	7.44	
12	7.44	7.26	7.19	6.84	7.18	7.35



PERL:

Table for Misprediction rate%

m/n	**2**	**4**	**6**	**8**	**10**	**12**
7	24.34	25.92	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:

- As observed from the above graphs we conclude that with an increase in "m" the misprediction rate decreases.
- We know that the size of the prediction table is related to "m" as follows: Prediction Table Size = 2^m. Now as we increase "m" the size of the prediction table will increase significantly. Now as size of the prediction table increases, more number of unique branch counters can be maintained. The reason is like the one that was stated for BIMODAL. Thus, we see a decrease in misprediction rate as we increase "m".
- Also from the above graphs we see that as we increase "n", misprediction rate increases.
- All three benchmarks show decrease in the misprediction rate with increase in "m".

2)

Table for Misprediction rate of all the given benchmarks for all variations of "m" and "n"

GCC

m/n	2	4	6	8	10	12	14	16
7	28.98	30.96	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		
13	11.11	10.57	10.59	11	11.68	12.68		
14	10.42	9.69	9.08	9.34	9.83	10.48	11.13	
15	10.13	9.13	8.3	8.22	8.46	9.01	9.48	
16	9.93	8.77	7.89	7.57	7.61	7.86	8.34	8.75

JPEG

m/n	2	4	6	8	10	12	14	16
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		
13	7.33	7.24	7.16	6.83	7.02	7.17		
14	7.32	7.17	7.14	6.69	6.34	6.84	6.93	
15	7.31	7.13	7.09	6.69	6.72	6.7	6.67	
16	7.31	7.13	7.08	6.65	6.7	6.66	6.57	6.68

PERL

m/n	2	4	6	8	10	12	14	16
7	24.34	25.92	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		
13	9.23	7.27	6.09	5.26	4.92	5.09		
14	8.07	7.35	5.43	4.51	3.8	4.3	3.75	
15	8.02	7.28	5.71	4.13	3.58	3.35	3.58	
16	8.04	6.54	5.07	4.12	3.84	3.53	3.01	2.91

DESIGN:

GCC TRACE: m=13, n=2, Misprediction rate=11.11

JPEG TRACE: m=11, n=4, Misprediction rate=7.88

PERL TRACE: m=12, n=4, Misprediction rate=8.09

For the above given values, we see that any increase in “m” does not significantly decrease the misprediction rate. We see that for any increase in the value of “m” beyond the above specified value the misprediction rate starts to level off and thereby the improvement in hardware only shows a minor improvement with an increase in the cost. Also, the above given “n” is the least value of “n” that can be selected, any increase in “n” beyond these values will increase the misprediction rate.