NC State University

Department of Electrical and Computer Engineering

ECE 463/521: Fall 2015 (Rotenberg)

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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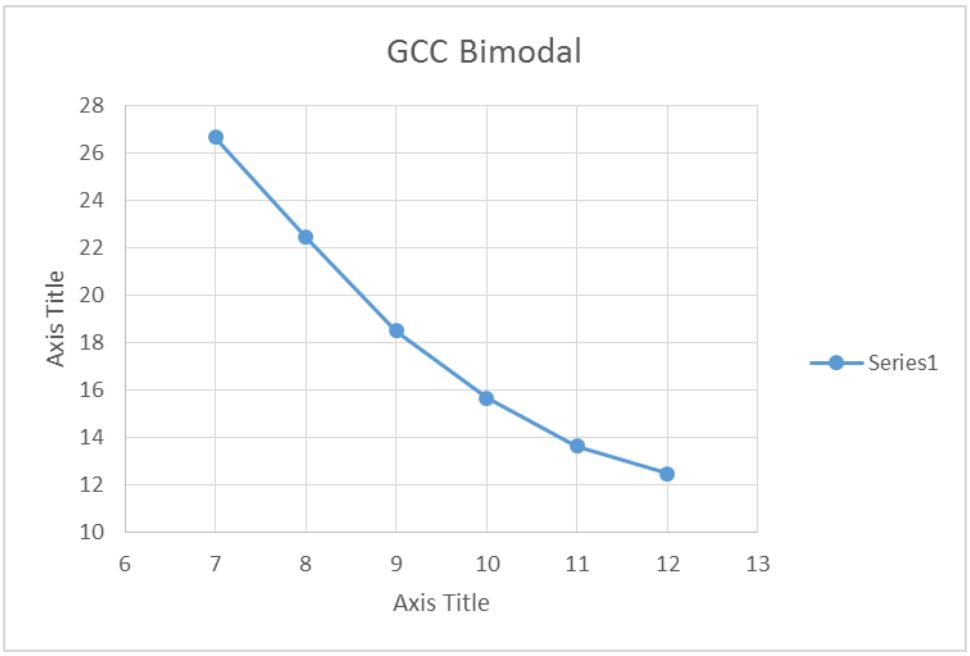
Course number: ECE 521

Branch Modal Predictor:

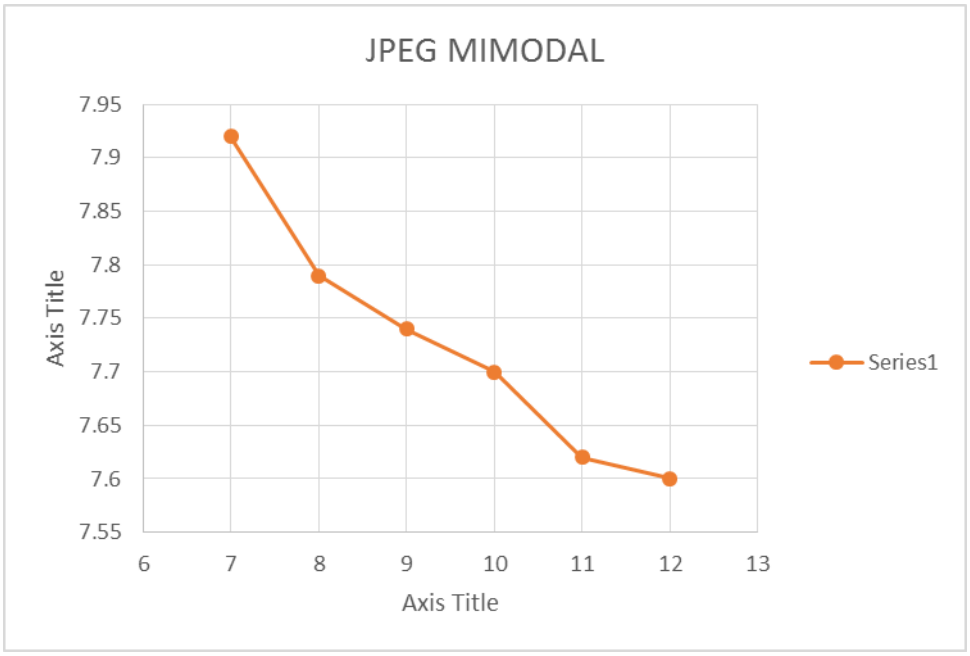
GCC

M2	missrate
7	26.65
8	22.43
9	18.49
10	15.67
11	13.65
12	12.47



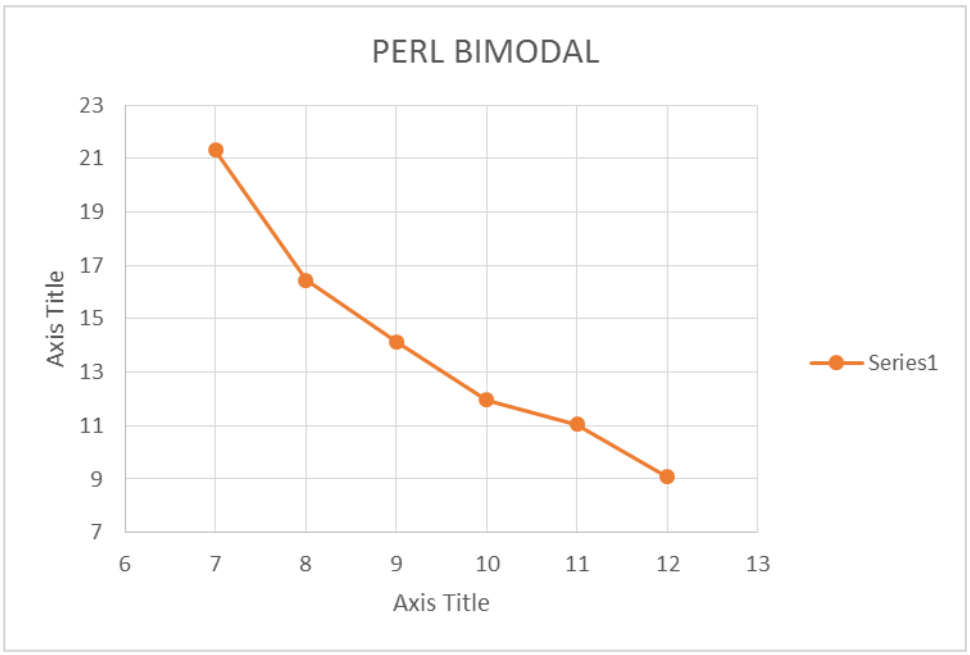
JPEG

M2	missrate
7	7.92
8	7.79
9	7.74
10	7.7
11	7.62
12	7.6



PERL

M2	missrate
7	21.31
8	16.45
9	14.14
10	11.95
11	11.05
12	9.09



The trend for different values of M is pretty much the same for all the traces as far as bimodal scenario is considered. However, we can observe that JPEG trace has lowest of all mis rate. This ca be due to the fact that it has quite a lot of repetions and hence an increase in predictions. As a geneal scneario, as value of M is increased , miss rate decreases which is true for every scenario.

Design

1) Memory budget of prediction table : 16Kb which will require 2^14 bits.
2) For a counter of 2 bit, , for M2 number of index bits, memory required = 2^M2 * 2 bits = 2^(M2-2).

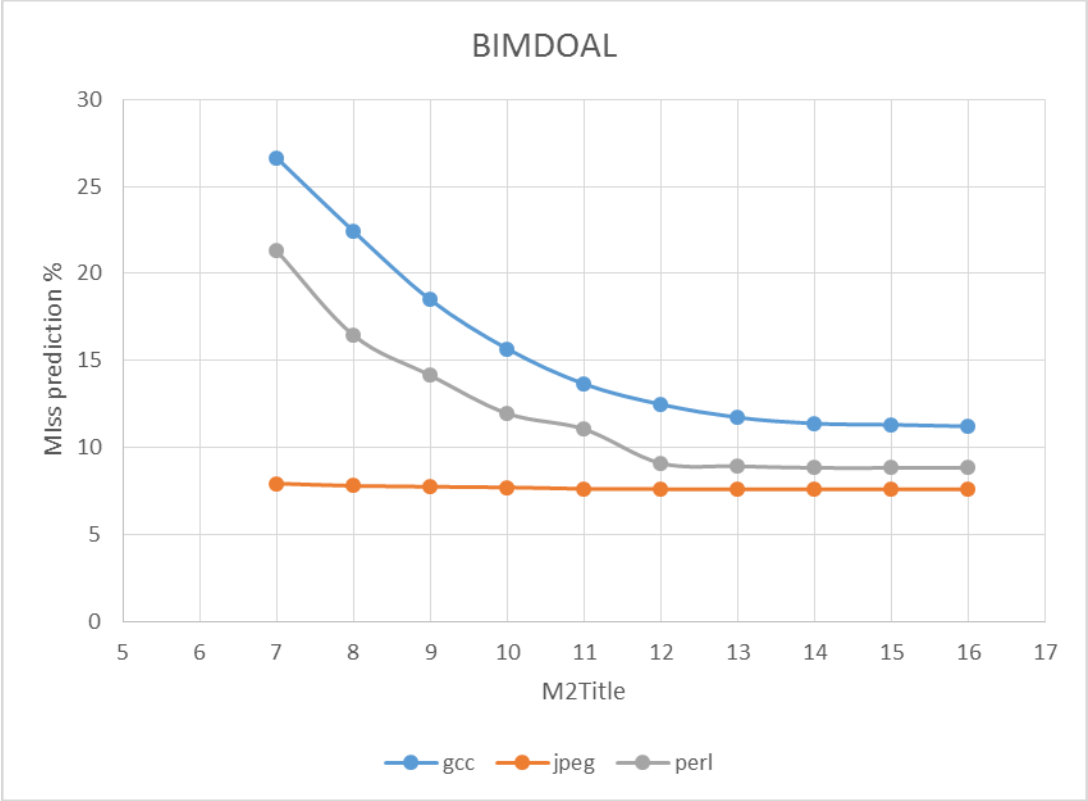
Therefore solving the above equation by comparing it with 2^14, we get M2 as 16

$$2^{(M2-2)}=2^{14}$$

M2=16

The above equation verifies that as M is increased, miss rate will decrease upto a certain point after which is might become constant. Therefore to observe this situation, we will start plotting miss rate upto M=16 for different traces.

M2	GCC	JPEG	PERL
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

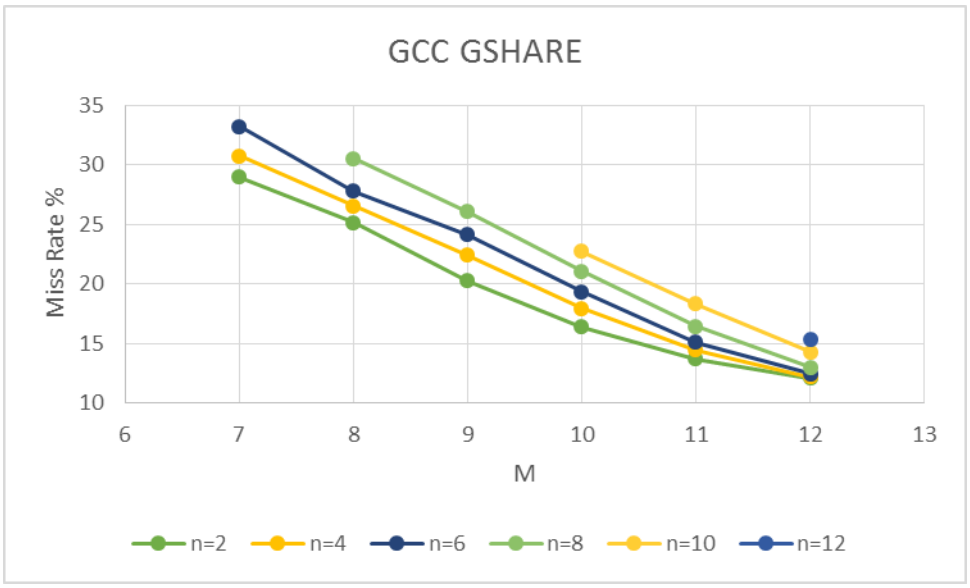


The above graph verifies our fact that as M@ is increased, upto a cetain point only miss % decreases, after that it starts to become constant irrespeciive of the trace chosen. Seeing the graph, we want to choose a minimum value of M2 from where the miss rate is constant. Hence for GCC it will be 15/16, For PERL it will be 12, and for JPEG it will be 13.

GSHARE

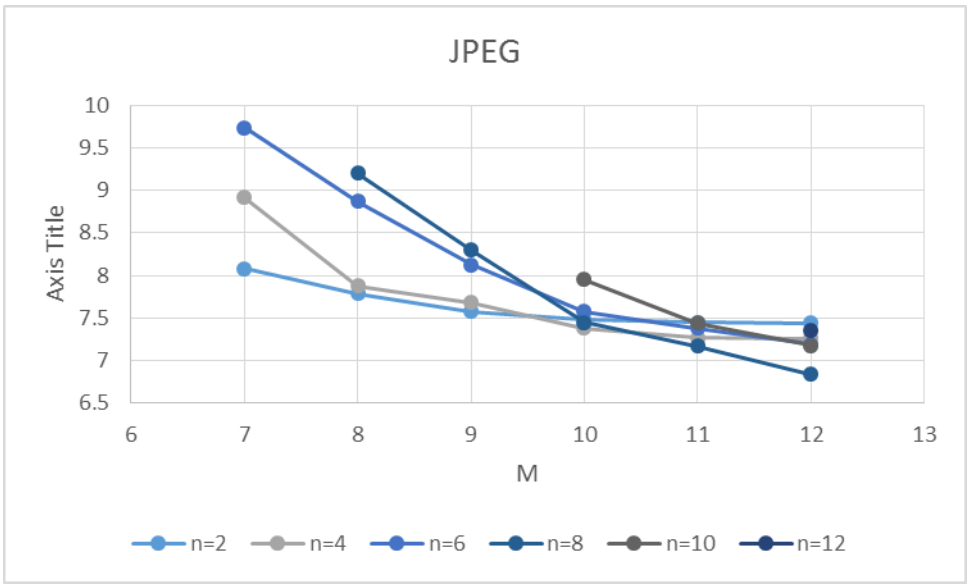
GCC

(n,m)	2	4	6	8	10	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	12.09	12.23	12.46	13	14.33	15.4



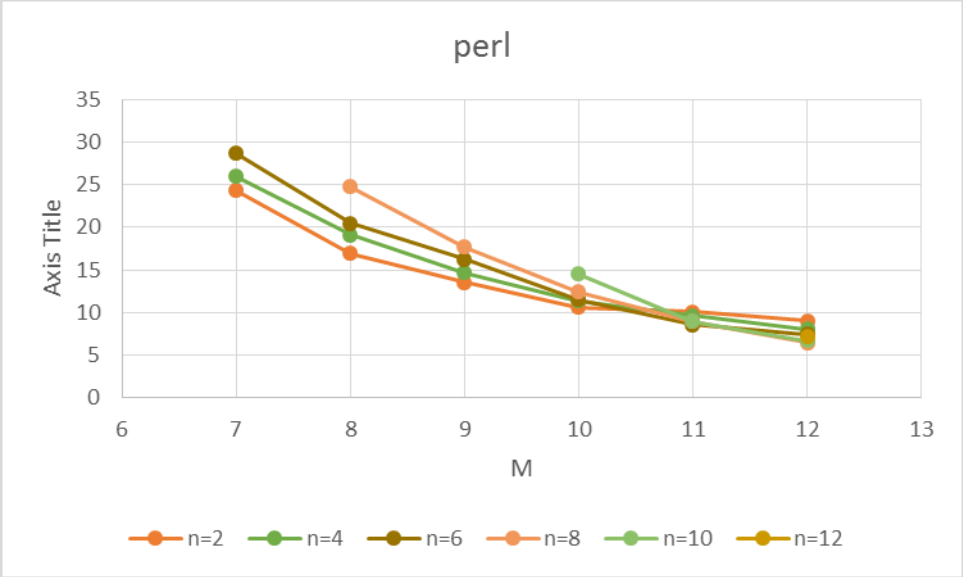
JPEG

	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

(n,m)	2	4	6	8	10	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



Observation

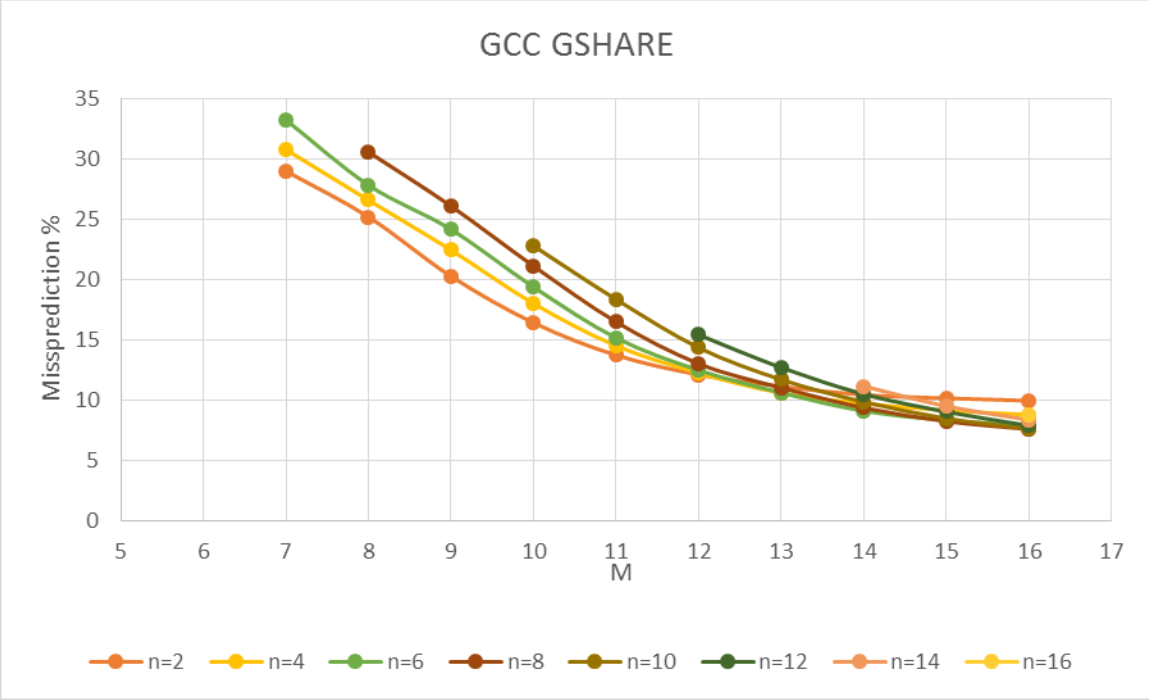
- In this case also, the miss rate depends upon different traces and trend is almost the same except for JPEG
- For GCC trace, the miss prediction rate increases or miss rate decreases as n is increased. The reason can be presence of similar branches in the trace.
- For JPEG trace, the trend is the same, miss rate decreases on n increases, however this is general, if we talk about a value of N, the trend is random, however overall it still decreases. The trends give us a picture that there are loops present indie the branches in the jpeg trend which has increased the prediction rate.
- For PEL the miss rate tends to merge as value of N is increased and hence there is an increase in performance

If we compare GSHARe and BIMODEL, we would find that GSHARE has a higher miss prediction rate than BIMODAL as long as M/N is small. Hower as it is increased, the graph falls sharply, and miss rate at higher value of N is almost similar to that of BIMODEL which implies they have similar performance for higher value of M/N.

Design:

GCC

(n,m)	2	4	6	8	10	12	14	16
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	12.09	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

(n,m)	2	4	6	8	10	12	14	16
7	8.08	8.92	9.74					
8	7.79	7.88	8.87	9.2				
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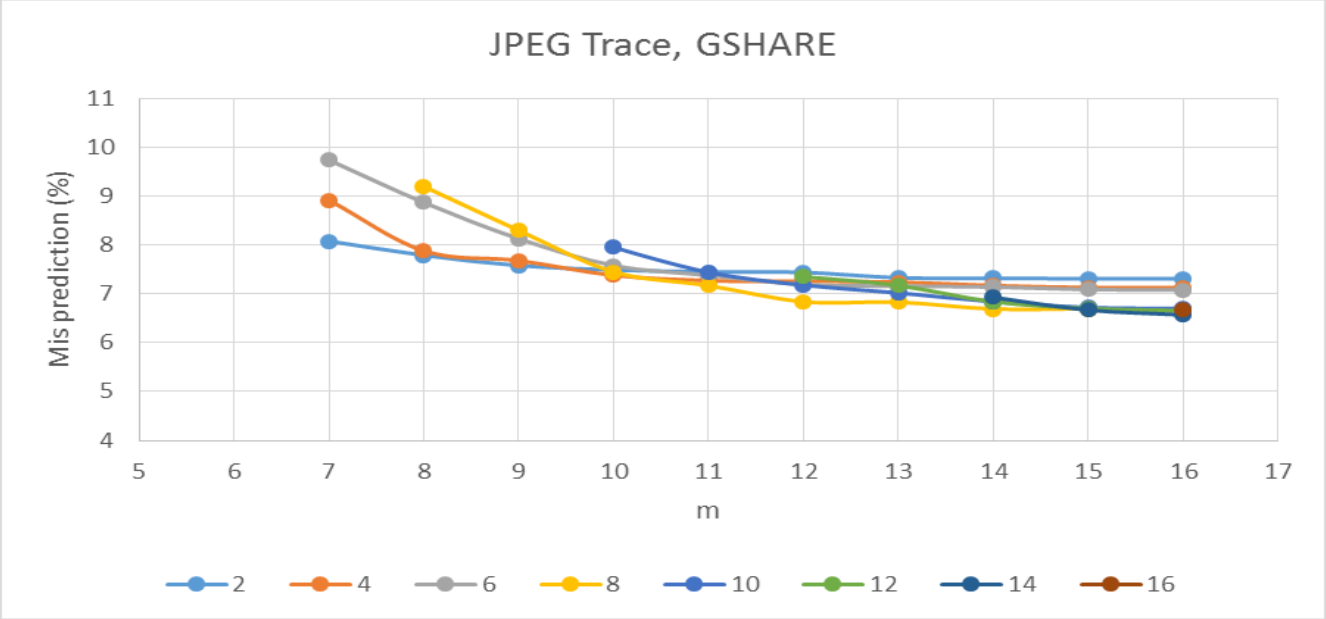
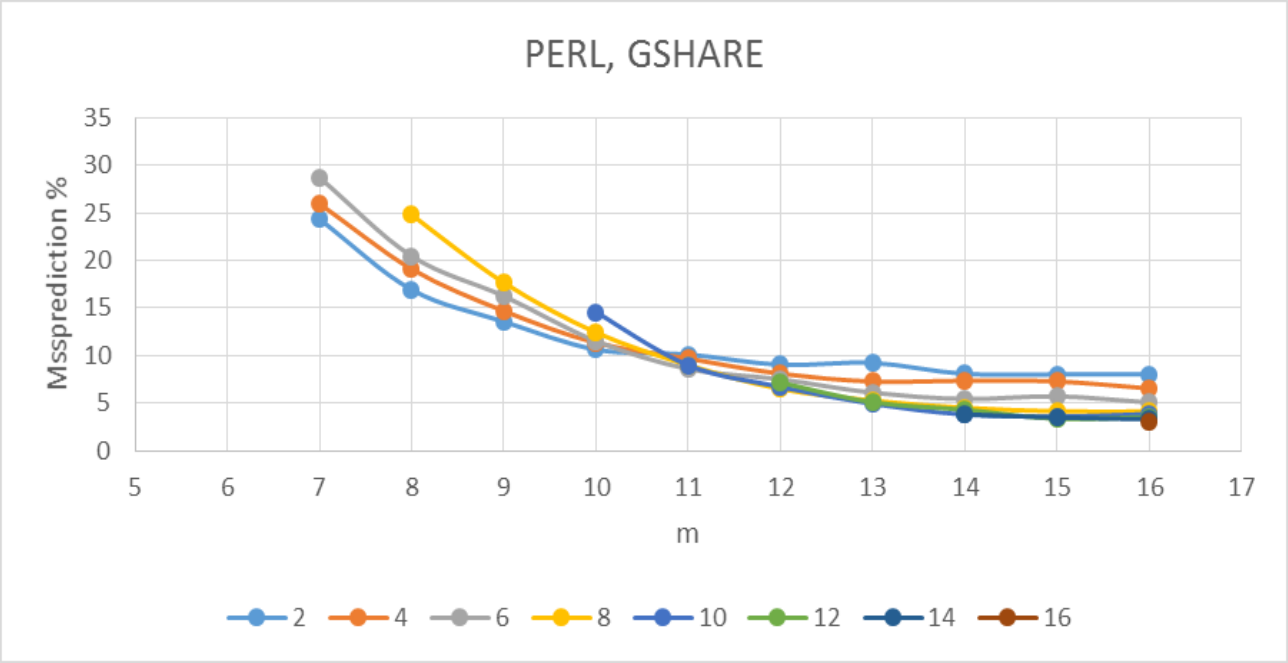
10	7.49	7.38	7.58	7.45	7.95			
11	7.45	7.27	7.38	7.17	7.44			
12	7.44	7.26	7.19	6.84	7.18	7.35		
13	7.33	7.24	7.16	6.83	7.02	7.17		
14	7.32	7.17	7.14	6.69	6.84	6.84	6.93	
15	7.31	7.13	7.09	6.69	6.72	6.7	6.67	
16	7.31	7.13	7.08	6.65	6.7	6.66	6.57	6.68



PERL

(n,m)	2	4	6	8	10	12	14	16
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		
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	3.82	
15	8.02	7.28	5.71	4.13	3.58	3.35	3.48	
16	8.04	6.54	5.07	4.12	3.84	3.53	3.3	3.01



The calculation is same as bimodal and hence M will be also 16 in this case. However the trends are little different as highlighted below.

The best performance is given by when history register width is set to 9 and M=16 in this case. Also for some values such as N=14,N-16,N=9, the performance is better tha nwhat we had with bimodal for M=16

The miss prediction rate for all traces follow a general trend overall. However, the best performance would still depend upon the applications and the required resources available.