NC State University

Department of Electrical and Computer Engineering

ECE 463/521: Fall 2015 (Rotenberg)

Project #2: Branch Prediction

by

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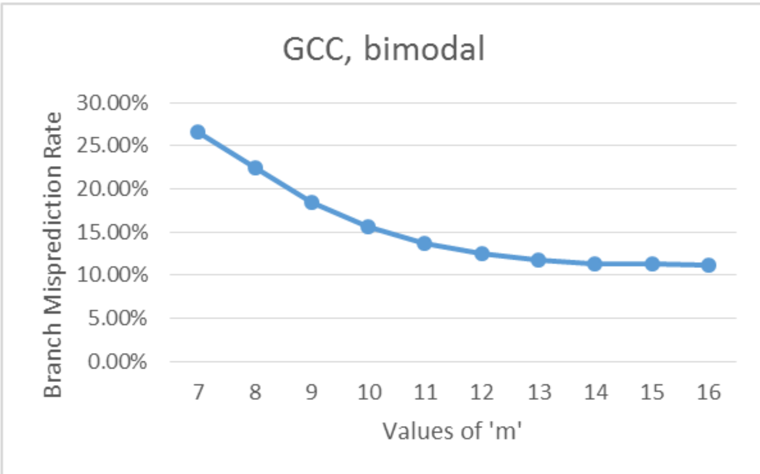
Course number: 521

PART 1: Bimodal Predictor

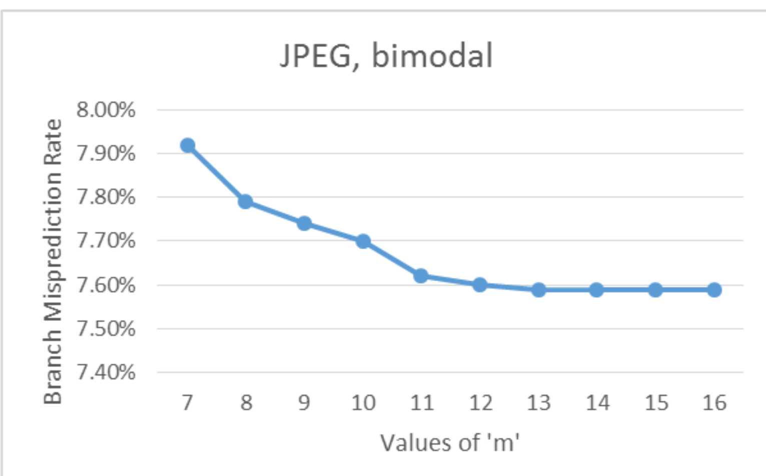
Individual Trace Analysis:

GCC trace:



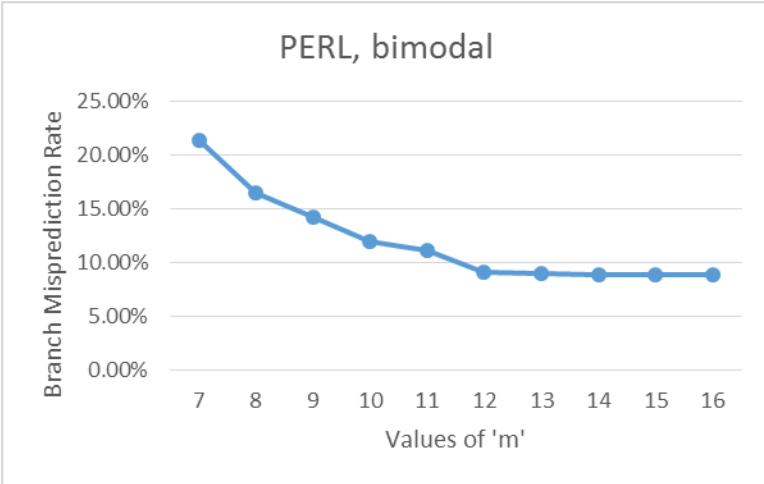
For the GCC trace, we find that the point of diminishing returns occur at m = 14. When we run this trace for values of **m** greater than 14, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Ergo, a bimodal predictor with m = 14 will be optimum for the GCC trace in terms of minimizing the misprediction rate and yet keeping predictor cost low.
Total cost of predictor table : 4 kilobytes.

JPEG trace:



For the JPEG trace, we find that the point of diminishing returns occur at m = 11. When we run this trace for values of **m** greater than 11, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Ergo, a bimodal predictor with m = 11 will be optimum for the JPEG trace.
Total cost of predictor table : 512 bytes.

PERL trace:



For the PERL trace, we find that the point of diminishing returns occur at m = 12. When we run this trace for values of **m** greater than 12, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Ergo, a bimodal predictor with m = 12 will be optimum for the PERL trace in terms of minimizing the misprediction rate and yet keeping predictor cost low.
Total cost of predictor table : 1 kilobyte.

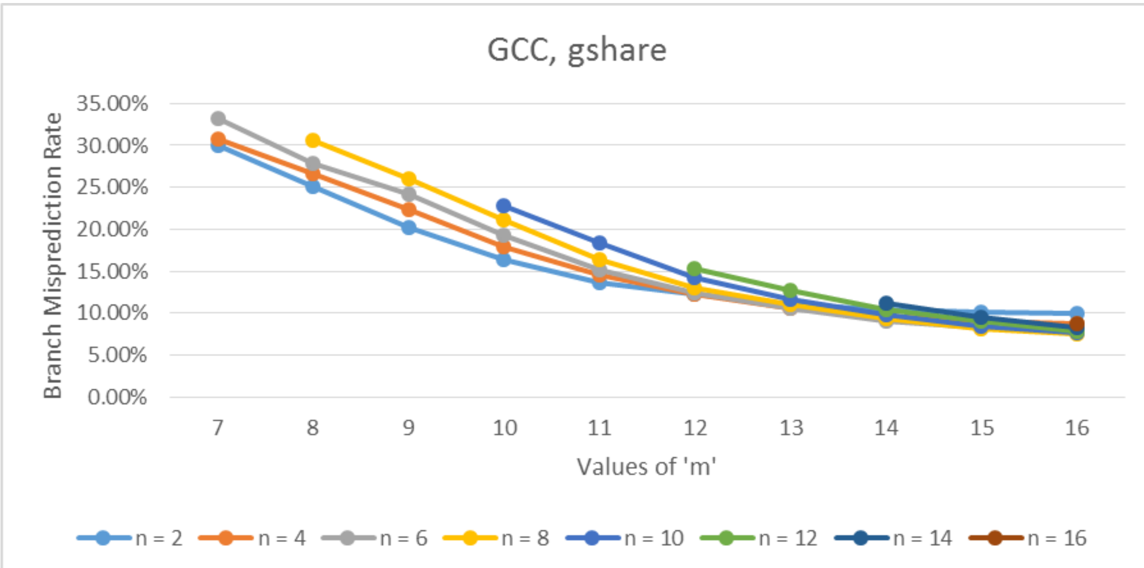
Overall Analysis:

We find that the JPEG trace incurs the least mispredictions among the three traces that were tested. Also, we find that after the **m** = 12 point, regardless of the trace, the misprediction rate doesn't reduce significantly upon increasing the size of the predictor table.
This is due to the fact that even if we use a maximum number of bits from the PC to index the table, there are bound to be instructions that will map to the same location in the predictor table (because their lower **m** bits are the same). Also, our predictions are only based on the previous local branch history, in case of the bimodal predictor, and as such, cannot be ascertained to be completely accurate. This is because previous branch behavior may not always be an accurate indicator of future behavior.

PART 1: GShare Predictor

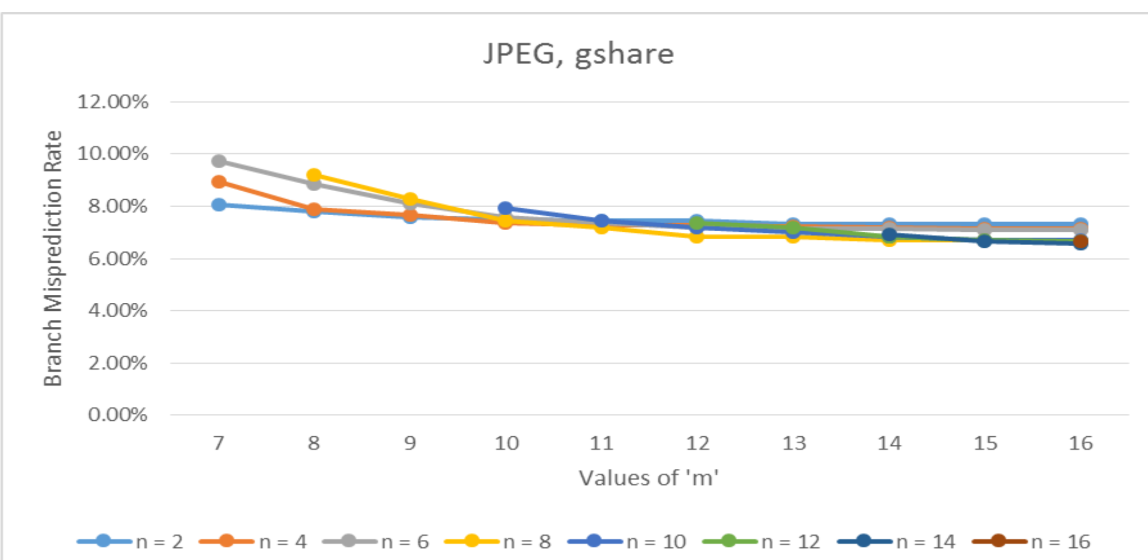
Individual Trace Analysis:

GCC Trace:



For the GCC trace, we find that the point of diminishing returns occur at m = 13, n = 6. When we run this trace for values of **m** greater than 13, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Also, we need to keep in mind the size of the Branch History Register and make a decision which minimizes it's cost (in nmber of bits). Therefore, a bimodal predictor with m = 13, n = 6 will be optimum for the GCC trace in terms of minimizing the misprediction rate and yet keeping predictor cost low.
Total cost of predictor table : 2 kilobytes.

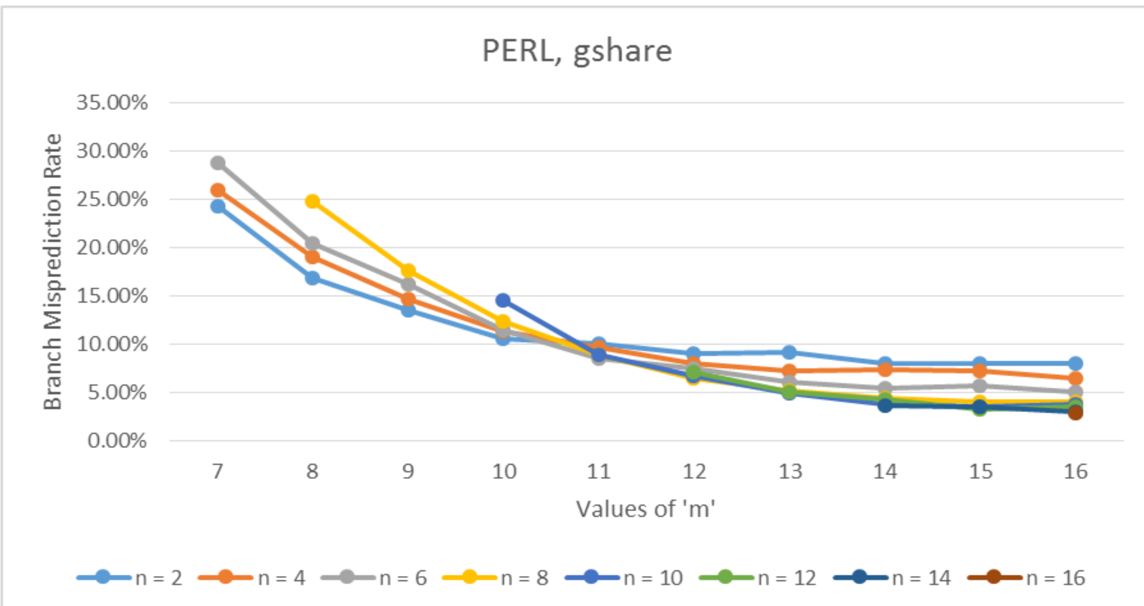
JPEG Trace:



For the JPEG trace, we find that the point of diminishing returns occur at m = 12, n = 8. When we run this trace for values of **m** greater than 12, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Also, **n = 8** produces the least misprediction rate for a predictor with **m = 12** (which provides a low enough misprdiction rate). Therefore, a bimodal predictor with m = 12, n = 8 will be optimum for the JPEG trace in terms of minimizing the misprediction rate and yet keeping predictor cost low.

Total cost of predictor table : 1 kilobyte.

PERL Trace:



For the PERL trace, we find that the point of diminishing returns occur at m = 13, n = 12. When we run this trace for values of **m** greater than 13, we find that the reduction in the Branch Misprediction Rate is not commensurate to the amount of additional hardware required to achieve those reductions. Also, **n = 12** produces the least misprediction rate for a predictor with **m = 13** (which provides a low enough misprediction rate). Therefore, a bimodal predictor with m = 12, n = 8 will be optimum for the PERL trace in terms of minimizing the misprediction rate and yet keeping predictor cost low.
Total cost of predictor table : 2 kilobyte.

Overall Analysis:

We find that the JPEG trace incurs the least mispredictions among the three traces that were tested. Also, we find that after the **m** = 12 point, regardless of the trace, the misprediction rate doesn't reduce significantly upon increasing the size of the predictor table.
This is due to the fact that even if we use a maximum number of bits from the PC to index the table, there are bound to be instructions that will map to the same location in the predictor table (because their lower **m** bits are the same).
Also, for a gshare predictor, we find that a small change in the number of BHR bits could have a rather large impact on the overall misprediction rate. Fewer bits (lower values of n) are likely to incur more misprediction as the even on XOR-ing with the higher **n** bits of the **m** bits of the PC, we are not able to get exclusive index values. This is intuitive since a limitation in the variety of inputs for an XOR operation is likely to limit the various outputs we can get.