ECE 586
COMPUTER ARCHITECTURE
TEAM 14
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For the competition predictor, we have used Hybrid predictor.

Overview:

The Gshare prediction table is indexed by the XOR result of the PC and the GHR, the Bimodal prediction table is indexed by the PC, and the Select Table prediction table has the same structure as the Bimodal prediction table. When the instruction fetch unit issues an instruction fetch request, the PC will also be generated at the same time. Finally, the prediction results of the Bimodal predictor and the Gshare predictor are selected through the prediction results of the Select table.

Branch Prediction Algorithm Description:

In this branch prediction mechanism, three key components are utilized: the Bimodal Predictor, the Gshare Predictor, and the Select Table Predictor. Each component serves a distinct purpose in predicting branch outcomes.

Bimodal Predictor:
 • Indexing: The Bimodal Predictor utilizes the Program Counter (PC) as the indexing mechanism. Each entry in the prediction table corresponds to a specific PC.
 • Prediction: Based solely on the PC, the Bimodal Predictor predicts whether a branch is likely to be taken or not taken.
 • Updation: Based on Branch outcome, it will be updated according to saturating counter.

G share Predictor:
 • Indexing: Unlike the Bimodal Predictor, the Gshare Predictor employs the XOR result of the PC and the Global History Register (GHR) as the index for its prediction table.
 • Prediction: By combining the PC and the GHR using XOR, the Gshare Predictor offers predictions based on global branch history, potentially enhancing prediction accuracy.
 • Updation: Based on Branch outcome, it will be updated according to saturating counter.

Select Table Predictor:
 • Structure: The Select Table Predictor shares the same structure as the Bimodal Predictor. Its prediction table is indexed by the PC.
 • Functionality: The Select Table Predictor serves as the arbitrator between the predictions generated by the Bimodal and Gshare predictors.
 • Selection Process: When an instruction fetch request is initiated, the PC is used to access both the Bimodal and Gshare predictors. Subsequently, the prediction results from these predictors are compared, and the Select Table Predictor determines which prediction to employ for the given branch.
 • Updation: Based on Branch outcome, it will be updated according to saturating counter.

Initial Assumptions:

Alpha Predictor	Hybrid Predictor	Increased Alpha Predictor
local_history = Not taken local_prediction = Strongly not taken global_prediction = Strongly not taken choice_prediction = Strongly Local path_history = Not taken	Bimodal = Strongly not taken Gshare = Strongly not taken Select_prediction = Strongly Bimodal GHR =_Not taken	local_history = Not taken local_prediction = Strongly not taken global_prediction = Strongly not taken choice_prediction = Strongly Local path_history = Not taken

Block Diagram:
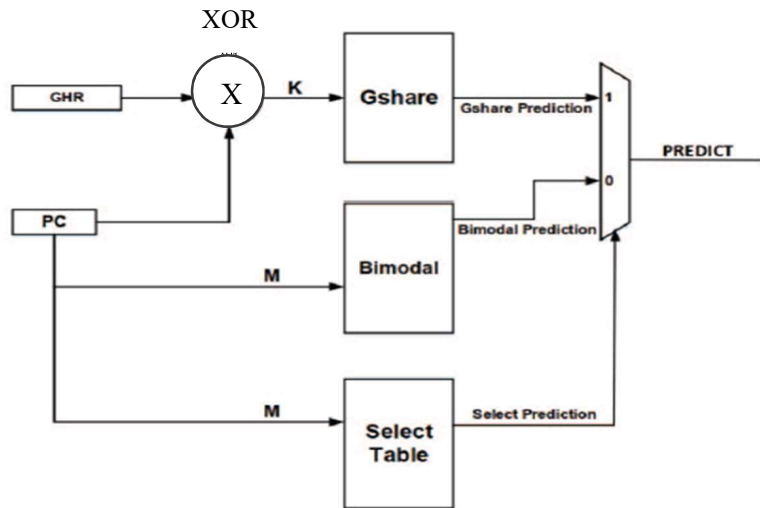
Space Budget:

A) **Hybrid Predictor**

GShare= 8kib x 2	= 16 kib
Bi-modal Predictor= 1kib x 2	= 2 kib
Select predictor= 1 kib x 2	= 2kib
Global Path History(GHR)	= 13 bits
Total	= 20 kib + 13 bits
	= 2.5 kiB + 13 bits

B) **21264 Tournament Branch Predictor**

Global Predictor = 4kib x 2	= 8 kib
Local Predictor= 1kib x 3	= 3 kib
Choice predictor= 4 kib x 2	= 8kib
Local History Table = 1kib x 10	= 10 kib
Global Path History	= 12 bits
Total	= 29 kib + 12 bits
	= 3.625 kiB + 12 bits

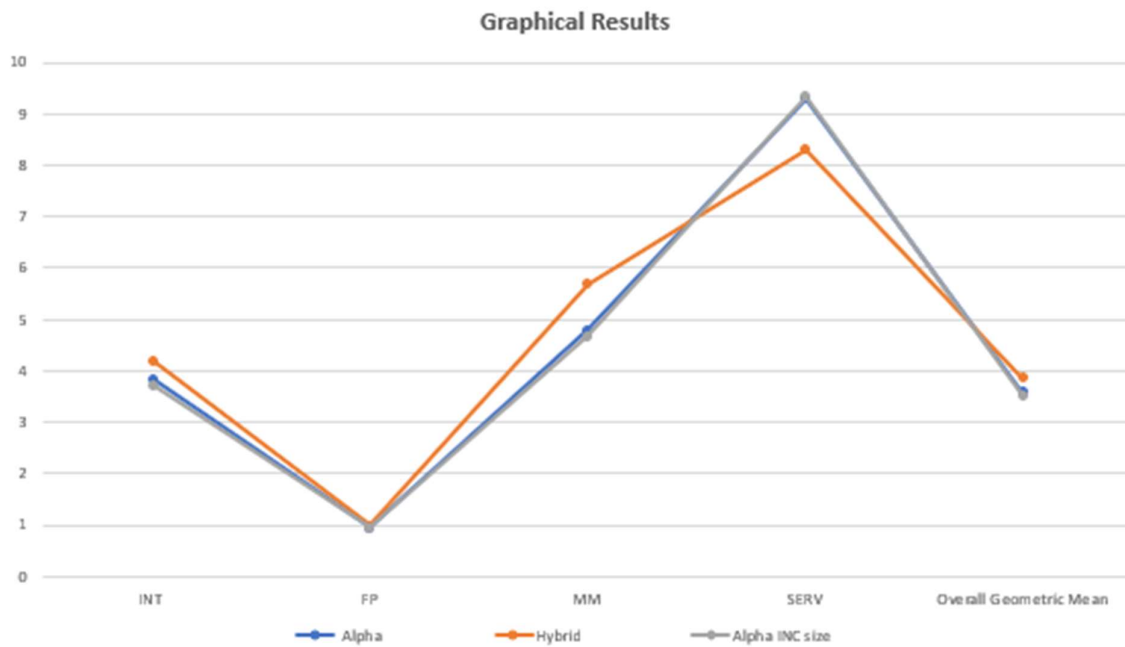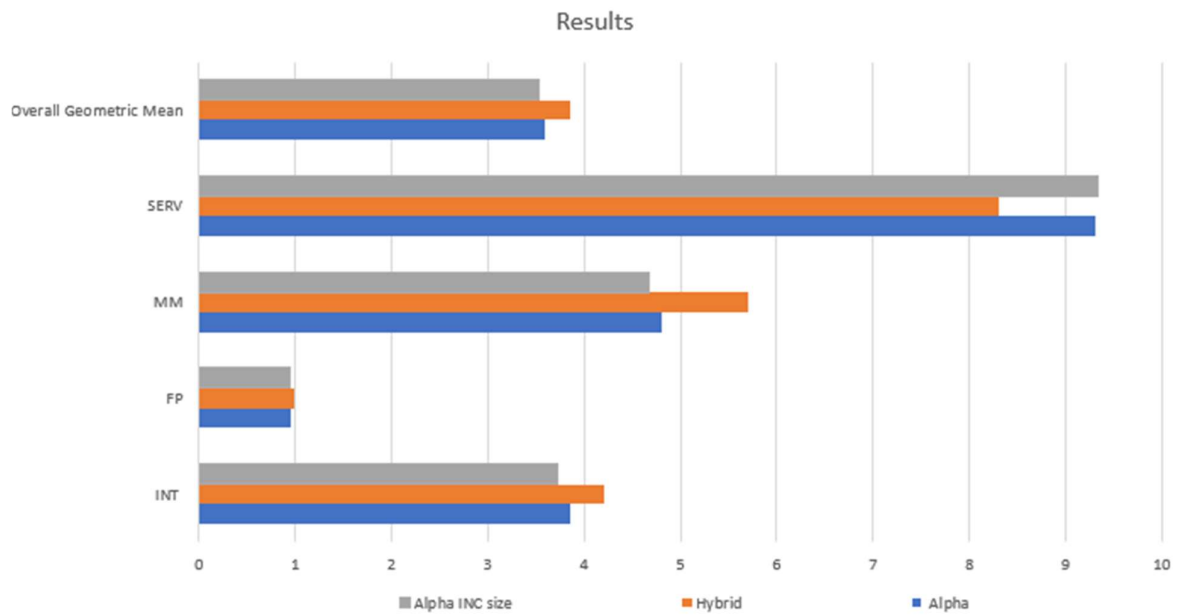C) **Tournament Predictor Wit Increased size**

Global Predictor = 4kib x 2	= 8 Kib
Local Predictor= 2kib x 3	= 6 kib
Choice predictor= 4 kib x 2	= 8kib
Local History Table = 1kib x 11	= 11 kib
Global Path History	= 12 bits
Total	= 33 kib + 12 bits
	= 4.125 kiB + 12 bits

Statistics:

Input Trace File	Alpha Predictor	Hybrid Predictor	Alpha Increased Size
DIST-INT-1	7.397	8.722	6.674
DIST-INT-2	9.715	9.235	9.643
DIST-INT-3	12.050	14.120	11.948
DIST-INT-4	2.425	2.728	2.367
DIST-INT-5	0.406	0.492	0.396
DIST-FP-1	3.286	4.349	3.263
DIST-FP-2	1.317	1.211	1.289
DIST-FP-3	0.518	0.514	0.519
DIST-FP-4	0.266	0.304	0.267
DIST-FP-5	1.397	1.698	1.397
DIST-MM-1	8.299	8.656	8.274
DIST-MM-2	10.970	10.734	10.938
DIST-MM-3	2.021	5.099	1.801
DIST-MM-4	2.165	2.085	2.162
DIST-MM-5	6.436	6.292	6.378
DIST-SERV-1	9.853	8.819	9.807
DIST-SERV-2	10.299	9.208	10.269
DIST-SERV-3	7.687	7.353	7.644
DIST-SERV-4	9.492	8.276	9.460
DIST-SERV-5	9.788	8.400	9.732

Geometric Mean:

	Geometric Mean of Alpha	Geometric Mean of Hybrid	Geometric Mean of Alpha INC size
INT	3.85	4.2	3.72
FP	0.96	0.99	0.95
MM	4.8	5.7	4.68
SERV	9.3	8.3	9.33
Overall Geometric Mean	3.59	3.86	3.53

Results

Graphical Results

References:

1) http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=755465&isnumber=1
   6354

2) Analysis and Optimization of the Branch Prediction Unit of SweRV EH1 | IEEE Conference
   Publication | IEEE Xplore