

Project 1 - gShare Predictor
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To determine the effect of various parameters on the prediction accuracy of the two bit local branch predictor and the tournament predictor, a series of tests were run. These tests included seven different combinations of parameters for each predictor on three different cpu traces. The cpu traces used were provided for this lab and are labeled 531.deepsjeng, 541.leela, and 548.exchange2.

In the case of the two bit local predictor, the parameters that were varied between runs were the local predictor size and the local counter bits. For the tournament predictor, local history table size, global predictor size, and choice predictor size were varied. Since global predictor size and choice predictor size should be the same value, they were kept equal for all the tests.

The results of these tests can be seen in Tables I and II below.

Local Predictor Size	Local Counter Bits	deepsjeng accuracy	leela accuracy	exchange2 accuracy	average accuracy
2048	1	82.197533	78.008789	72.234383	77.48024
2048	2	85.870590	82.686928	82.541389	83.69964
4096	2	86.647888	82.814774	82.562042	84.00823
8192	2	86.989662	83.000610	82.570908	84.18706
16384	2	87.057266	83.011482	82.575905	84.21488
32768	2	87.057457	83.012451	82.576729	84.21555
65536	2	87.057457	83.012520	82.577171	84.21572

Table I: Two-bit Local Branch Predictor Test Results

Local History Table Size	Global Predictor Size	Choice Predictor Size	deepsjeng accuracy	leela accuracy	exchange2 accuracy	average accuracy
2048	8192	8192	91.214111	84.405563	95.447472	90.35572
4096	8192	8192	91.501961	84.551926	95.471436	90.50844
4096	16384	16384	92.247910	85.238235	95.683807	91.05665
4096	32768	32768	92.908279	85.944687	95.926682	91.59322
8192	32768	32768	92.990631	86.005333	95.937889	91.64462
8192	65536	65536	93.339989	86.417328	95.790962	91.84943

16384	1048576	1048576	94.586838	88.716820	96.718124	93.34059
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Table II: Tournament Branch Predictor Test Results

One thing to note is that only three tests were required for the tournament branch predictor but seven were run. The required tests are the three tests above the black line in the table. Extra tests were run to get a better sense of how the prediction accuracy changed with larger history tables and global/choice predictors. All changes, except the last, increased one parameter by 2x with the exception of the final test for the tournament predictor. This final test increased the parameters by a much larger margin to determine if the improved prediction accuracy continued for extremely large values.

In the case of both predictors, the larger value already resulted in the better prediction. However, the law of diminishing returns applies here and with very large predictor parameters, the prediction accuracy only saw marginal improvement. For this reason, it might not make sense to go above a local predictor size of 4096 for the two-bit local predictor and 4096 for the local history table size in the tournament branch predictor. 16384 is likely the best middle ground between complexity and accuracy for the tournament predictor's global and choice predictor sizes. Although a size of 32768 does see an improvement of over 0.5% in prediction accuracy, it does so by significantly increasing the size of these tables.

Next, after implementing a gShare predictor, more tests were run. This time the global predictor size and global counter bits were varied. In order to maintain consistency, these values were varied in the same way the local ones were varied in the two-bit local predictor tests. The results can be seen in Table III below.

Global Predictor Size	Global Counter Bits	deepsjeng accuracy	leela accuracy	exchange2 accuracy	average accuracy
2048	1	79.876968	73.154922	86.594101	79.87533
2048	2	82.395012	75.462029	89.650146	82.5024
4096	2	85.289474	77.581154	91.617897	84.82951
8192	2	87.695053	79.727676	92.821175	86.74797
16384	2	89.733002	81.566856	93.692764	88.33087
32768	2	91.293930	83.207008	94.376556	89.62583
65536	2	92.410385	84.694702	95.005775	90.70362
131072	2	93.246002	85.869598	95.541512	91.55237
1048576	2	94.502731	88.207291	96.496521	93.06885

Table III: gShare Branch Predictor Test Results

As with the other two predictors, the prediction accuracy for gShare increased with respect to global/local predictor size. However, unlike the other methods, the law of diminishing returns took longer to take hold. As for prediction accuracy, the results of this test show that gShare appears to perform better than the two-bit local predictor on these cpu traces but still not as well as the tournament predictor.

As with the tournament predictor, a couple of very large global predictor sizes were tested with the gShare predictor as well. When these values get really large, it seems that the gShare prediction accuracy starts to approach the tournament predictor accuracy.

It seems that with these three predictors, the prediction accuracy is related to the complexity of the predictor itself. With the two-bit local predictor (the simplest) having the worst predictions. The data also shows that the larger the tables the predictors use, the better the predictions become, but the improvement has diminishing returns with very large values.