BRANCH PREDICTOR REPORT

BRANCH PREDICTOR COMPARISON

Implementation with Accuracy Table

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Git Hub Link

https://github.com/Adityagarg-github/RISCV-Assembler

Implementation Details :

1. Please go through the assembly code for extracting the target labels by identifying all the branch instructions and then storing them in an array.
2. Using the trace compare the branch labels with actual behavior. Maintain a boolean array for each branch, Insert 0 for not taken and 1 for taken in the boolean array.
3. Then implement branch prediction for always not taken, always taken, 1-bit, and 2-bit.
4. Then we will calculate the accuracy of each of the predictors. This accuracy can be calculated by comparing the actual branch outcome in the boolean array with predicted outcomes from the implemented prediction rule.
5. Accuracy = Total Correct Predictions / Total branch Instructions

	Bubble_test_lab	Fac_test_lab	sqrt_test_lab	qsort_test_lab	Recursion_test_lab	wikisort_test_lab	recursion_test_lab
Always Taken	43.3526	72.4425	71.0993	74.518	76.56	69.9638	88.1045
Always Not Taken	56.6474	27.5575	28.9007	25.482	23.44	30.0362	11.8955
1-bit	97.1571	90.8259	96.7603	94.5191	96.3638	96.9859	82.5039
2-bit	98.384	92.067	97.3449	95.2484	96.5174	97.7713	84.1722

Observation -

1. Dynamic predictors have more accuracy than static ones.
2. A 2-bit predictor has more accuracy than a 1-bit

Theory

Branch Predictor Types

Always Not Taken

Always predicts that the branch will not be taken regardless of branch history or outcome of previous executions.

Always Taken

Always predicts that the branch will be taken regardless of the branch's history or the outcome of previous executions.

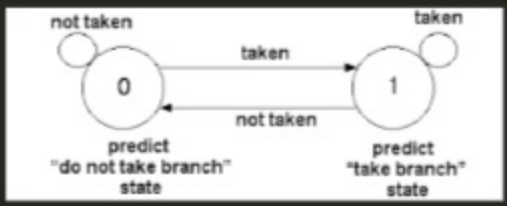
1-bit

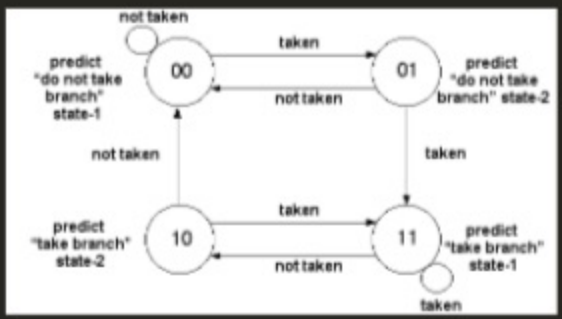
Does binary prediction of each instruction as taken or not taken. Uses a single bit saturating counter for prediction.
1 is predicted as taken
0 is predicted as not taken

2-bit

It does binary prediction use a 2-bit counter. It has 4 states and offers better predictions, especially for branches with complex behavior.
Strongly Not Taken (00): Predicts not taken.
Weakly Not Taken (01): Predicts not taken.
Weakly Taken (10): Predicts taken.
Strongly Taken (11): Predicts taken.

State diagram





Result

2-bit predictors are better than 1-bit ones due to better accuracy and similarly dynamic predictors are better than static ones too.