RISCV Assembler - Branch Predictor Comparision

Mudit Gupta	2022CSB1094@iitrpr.ac.in
Rakshit Kaushal	2022CSB1110@iitrpr.ac.in
Animan Naskar	2022CSB1297@iitrpr.ac.in

	quick-sort	recursion	factorial	bubble-sort	sqrt	average
1-bit	94.8	96.8	91.2	97.2	96.8	95.4
2-bit	95.7	97.2	92.5	98.4	97.3	96.2
always-not-taken	45.3	39.6	51.5	56.6	28.9	44.4
always-taken	54.7	60.4	48.5	43.4	71.1	55.6
maximum	95.7	97.2	92.5	98.4	97.3	96.2

Accuracy in %

GitHub Code	RISCV Assembler Branch Predictor

Implementation Details:

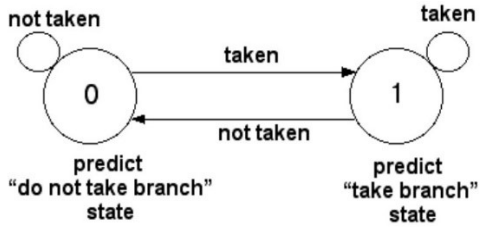
1. Label Extraction:
   - Parse the assembly code to identify branch instructions.
   - Extract the target labels from each branch instruction and store them in an array.
2. Execution Trace and Boolean Array:
   - Follow the trace and compare branch labels with actual behaviour
   - Insert 1 (taken) or 0 (not taken) into a boolean array at each branch.
3. Branch Prediction Rules:
   - Implement branch prediction rules for always-not-taken, always-taken, 1-bit, 2-bit branch predictors.
4. Accuracy Computation:
   - Compare the actual branch outcomes in the boolean array with the predicted outcomes from the implemented prediction ru
   - Calculate the accuracy of the branch predictor using the formula:

$$\text{Accuracy} = \frac{Correct\ Predictions}{Total\ Branch\ Instructions}$$

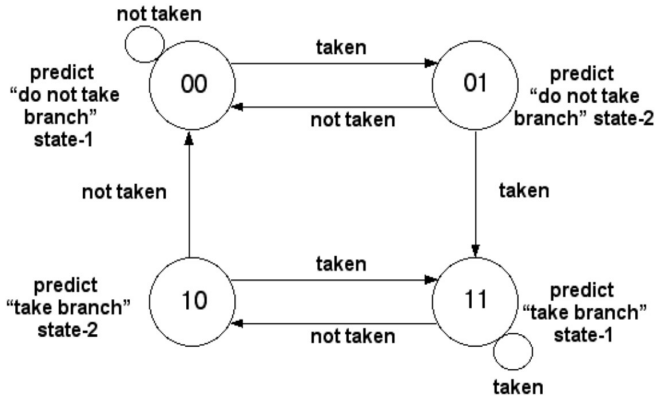
Theory:

Branch Predictor Types	
Always-not-taken	Always predicts that a branch will be taken.
Always-taken	Always predicts that a branch will not be taken.
1-bit	Uses a 1-bit counter to track the history of a branch (taken or not taken). Predicts based on the current state of the counter: 0 or Not Taken: Predicts not taken. 1 or Taken: Predicts taken.
2-bit	Uses a 2-bit counter to track the history of a branch (taken or not taken). Predicts based on the current state of the counter: 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



1-bit



2-bit