BRANCH PREDICTION

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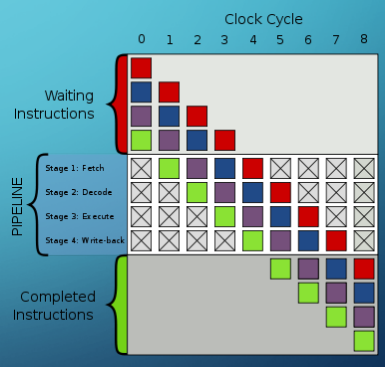
WHAT IS BRANCH PREDICTION

- A branch predictor guesses which way a branch will go
- The proper branch cannot be known until the execute stage is completed
- Modern pipelines are often 15 to 20 stages long, so lots of time is lost if no prediction or incorrect prediction occurs

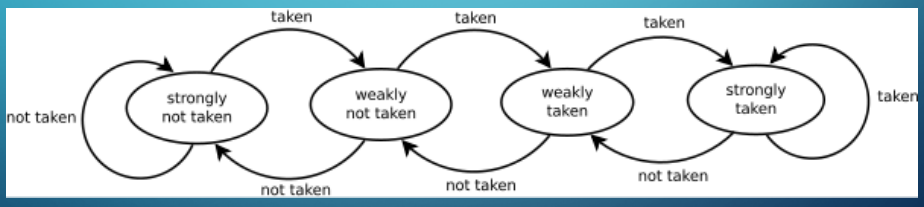


STATIC PREDICTION

- Simplest form of branch prediction
- Always predicts either taken or not taken
- Early versions of the SPARC and MIPS architectures used Static Prediction
- Some early Intel processors allowed the predictor to receive hints from the code to tell it to predict taken or not taken, but this is no longer used
- Static prediction is often the fallback for dynamic predictors when they don't have the information required to make a decision

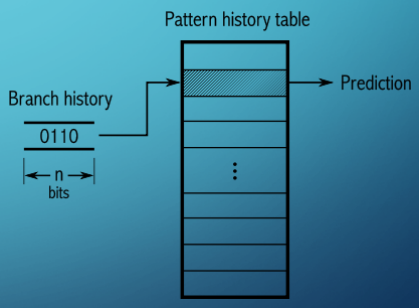
SATURATING COUNTER

- Every branch receives its own counter
- Saturates to 93.5% accuracy



TWO-LEVEL ADAPTIVE PREDICTOR

- Remembers what happened the last n times for each branch
- Uses a saturating counter for each of the 2^n history patterns (right)
- Used in almost all modern processors



LOCAL BRANCH PREDICTOR

- Like a Two-Level Adaptive Predictor except it has a History Buffer for EACH conditional jump instruction
- Pattern History Table may or may not be shared
- Used in many Intel Pentium processors (4-bit buffer, 16 entry pattern table)
- Saturates to 97.1% accuracy

GLOBAL BRANCH PREDICTOR

- Like the Local Branch Predictor, except it does not keep a separate history for each conditional jump
- This shared history allows it to recognize correlation between separate branches
- Requires a very large table size to be useful

AGREE PREDICTOR

- Combination of Saturating Counter, Two-Level Adaptive, and Global Branch Predicotrs
- Uses Two-Level Adaptive Prediction, A Globally Shared History Buffer and Pattern History Table, and a local Saturating Counter
- Outputs are XORed together to give the final prediction
- Developed by Intel, but eventually abandoned

HYBRID PREDICTOR

- Combination of multiple prediction methods
- Either remembers which predictor has been correct the most, or it has a voting system where each predictor makes its prediction and it chooses whichever one got the most votes

LOOP PREDICTOR

- Best used for conditional jumps that control loops
- If at the bottom of a loop, it repeats n times and will be taken n-1 times and not taken 1 time
- If at the top of a loop, it will be not taken n-1 times and taken 1 time
- Useful for any jump that goes one way many times and then the other way once
- Often used in modern processors

OVERRIDING BRANCH PREDICTOR

- Most accurate branch predictors are slow, and most fast branch predictors are inaccurate, but we want fast and accurate
- Overriding Branch Predictors are a combination of two branch predictors, one that is very fast, and another that is accurate
- The fast branch predictor's prediction will be taken while the slower predictor is deciding
- The slower predictor will override the fast predictor if it predicts differently
- Used in almost all modern processors

QUESTIONS?

INDIRECT JUMP PREDICTOR

- Chooses between more than two branches
- Uses a two level adaptive predictor, but each branch contributes more than one bit to the history buffer
- If a processor does not have indirect jump prediction, it will predict an indirect jump to go to the same target it has previously