Branch Prediction Exploration Project

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CSE 470

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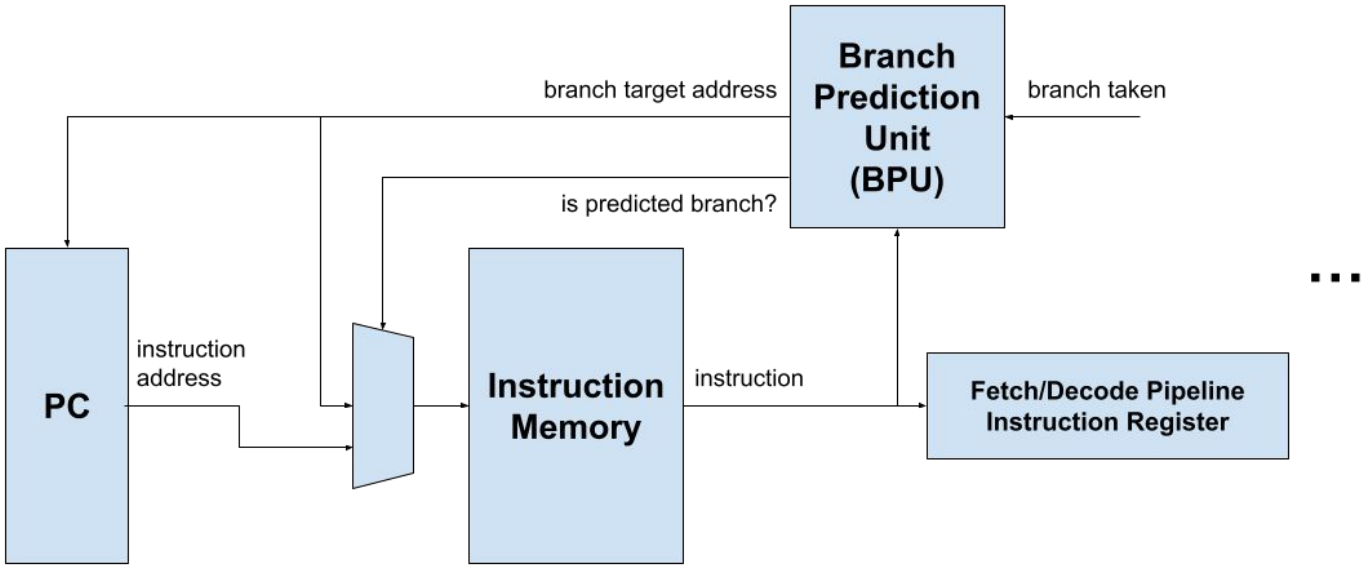
Background

- Wide Spectrum of Branch Prediction
  - Prediction Type
  - Implementation
- Importance of Good Branch Prediction is Growing
  - More Pipeline Stages = Greater Misprediction Penalty
  - More Specialized Hardware = More Specialized Prediction

Project Goals

- Expand familiarity with implementation and testing of branch predictors
- Experiment with techniques to test performance of branch predictors
- Gain insight for performance given program structures

Branch Prediction Unit Design



Branch Prediction Strategies

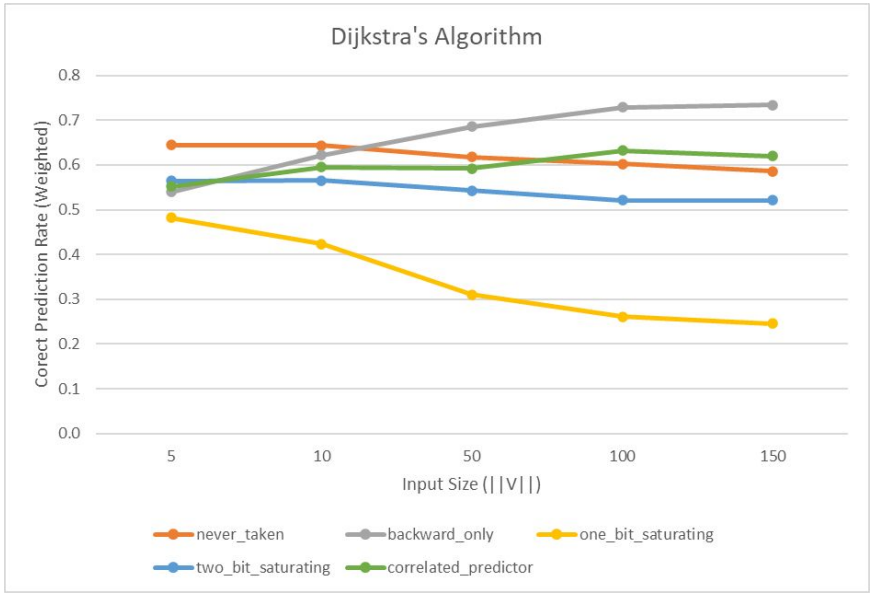
- Static
  - Always/Never Taken
  - Only Forward/Backward

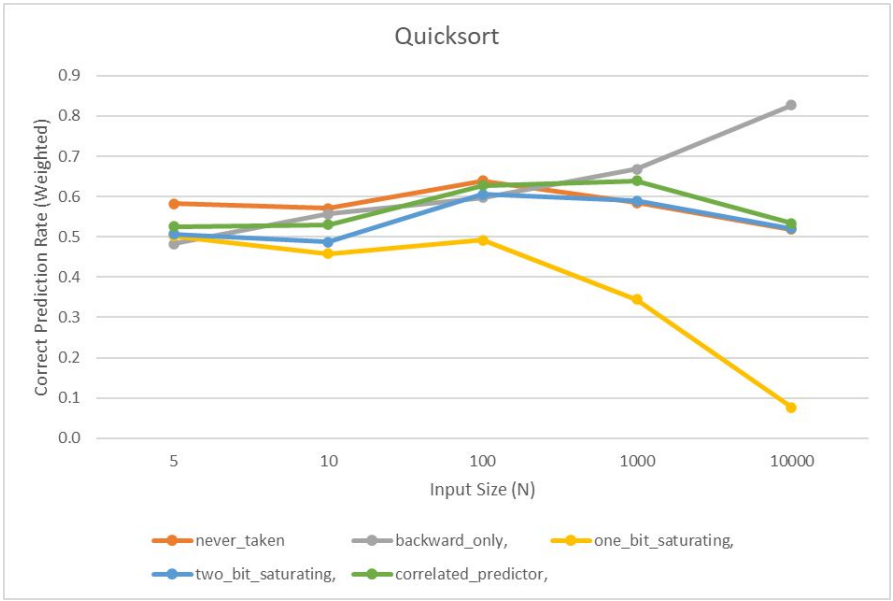
- Dynamic
  - N-bit Saturating Counter (1 and 2)
  - Correlated Predictor

Experimental Design

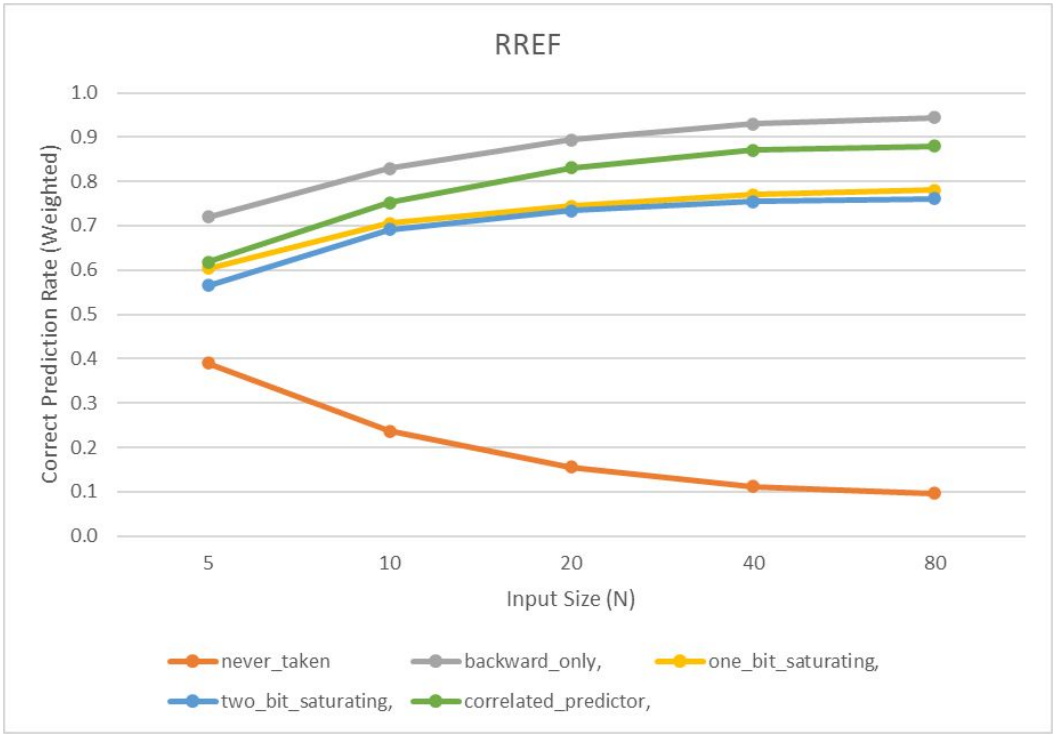
- Test Performance on Different “Classes” of Programs
  - Program Type (Sorting, Graphs, Arithmetic, etc.)
  - Time Complexity
- Gather data over spectrum of input sizes

Results


Dijkstra's Algorithm
Corect Prediction Rate (Weighted)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5
10
50
100
150
Input Size (||V||)
never_taken
backward_only
one_bit_saturating
two_bit_saturating
correlated_predictor


Quicksort
Correct Prediction Rate (Weighted)
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5
10
100
1000
10000
Input Size (N)
never_taken
backward_only,
one_bit_saturating,
two_bit_saturating,
correlated_predictor,

Results


RREF
Correct Prediction Rate (Weighted)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
5
10
20
40
80
Input Size (N)
never_taken
backward_only,
one_bit_saturating,
two_bit_saturating,
correlated_predictor,

Further Study

- Many more prediction strategies and programs to test!
- Need more experimentation and data on parameters for predictors
- Different Performance Characteristics to Measure
- Large opportunity to greatly increase efficiency to gather more data

References

- https://courses.cs.washington.edu/courses/csep548/06au/lectures/branchPred.pdf
- https://link.springer.com/article/10.1007/s10462-022-10221-5
- https://arxiv.org/pdf/1906.08170.pdf
- https://course.ece.cmu.edu/~ece740/f13/lib/exe/fetch.php?media=onur-740-fall13-module7.4.1-branch-prediction.pdf\

Questions?

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