Wormhole: Wisely Predicting Multidimensional Branches

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CONTRIBUTIONS

- Identify branches that exhibit multidimensional correlations. These are branches that (1) are enclosed within nested loops and (2) exhibit correlation across iterations of the outer loops.
- Present wormhole, a novel low-cost side-predictor that is specialized for multidimensional branches.

Wormhole Predictor

Entry in wormhole prediction table.

(a) First encounter diagonal branch pattern; (b) Correctly predict diagonal branch pattern on second encounter.

Wormhole prediction example.

Example multidimensional branches. (a) Program 1; (b) Branch 1 outcome in Program 1; (c) Program 2; (d) Branch 2 outcome in Program 2.

WISL-TAGE

Wormhole is implemented on top of ISL-TAGE.

- Statistical corrector identifies branches that are frequently mispredicted by the base TAGE predictor; these branches are fed to wormhole.
- Loop predictor detects the number of iterations in the current inner loop; used by wormhole to determine dimensionality.

MULTIDIMENSIONAL BRANCHES

Program 1
// X is a vector with the position of objects
// randomly placed in a 3D space
// p is a point in the 3D space
while(true)
for (j=0; j<NumObjects; j++) // Loop 2
if (distance(X[j], p) < threshold) // Branch 1
/* do something */

Program 2: Jacobi1 algorithm
// A is the matrix
// B is the right hand side
// X is the current solution estimate
// X0 is the partial solution

Evaluation

MPKI reduction with respect to ISL-TAGE, for 4KB and 32KB base predictors.