DSPatch: Dual Spatial Pattern Prefetcher

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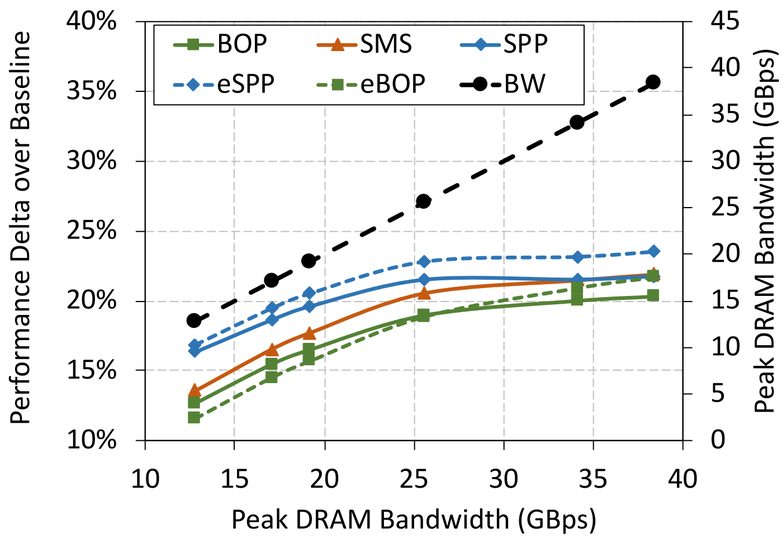
1. Motivation

- Current state-of-the-art spatial prefetcher performance plateaus despite increasing memory bandwidth

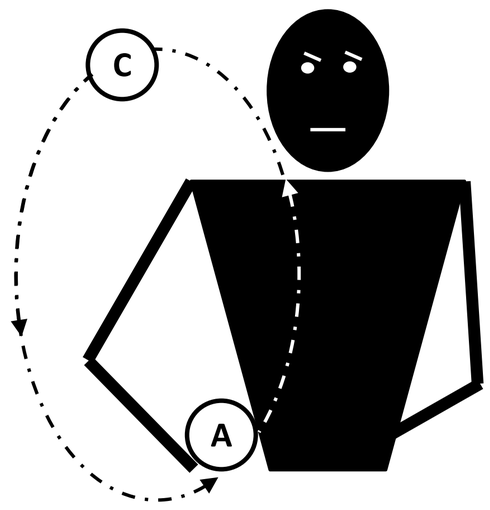
⇒ Need to boost speculation and coverage to maximize utilization of memory bandwidth resource



2. Challenge

- Fundamental tradeoff in traditional prefetcher design between ***Coverage*** versus ***Accuracy***

⇒ Limits ability to dynamically adapt to memory bandwidth headroom and significantly *boost* ***Coverage***



3. Goal

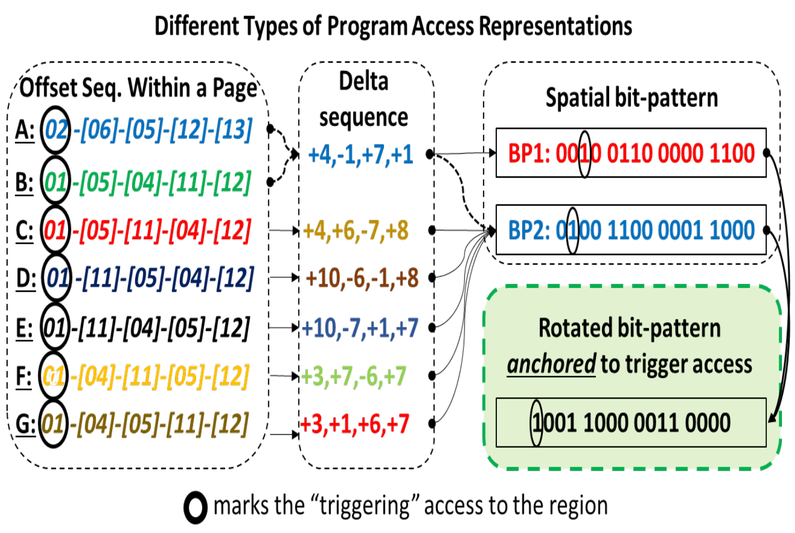
New prefetcher design should include:

1. Pattern representations best suited to capture spatially co-located program accesses and *boost* ***Coverage***
2. Mechanisms to simultaneously optimize for *both* ***Coverage*** *and* ***Accuracy***
3. Ability to dynamically adjust aggressiveness (Coverage vs. Accuracy) based on available DRAM bandwidth

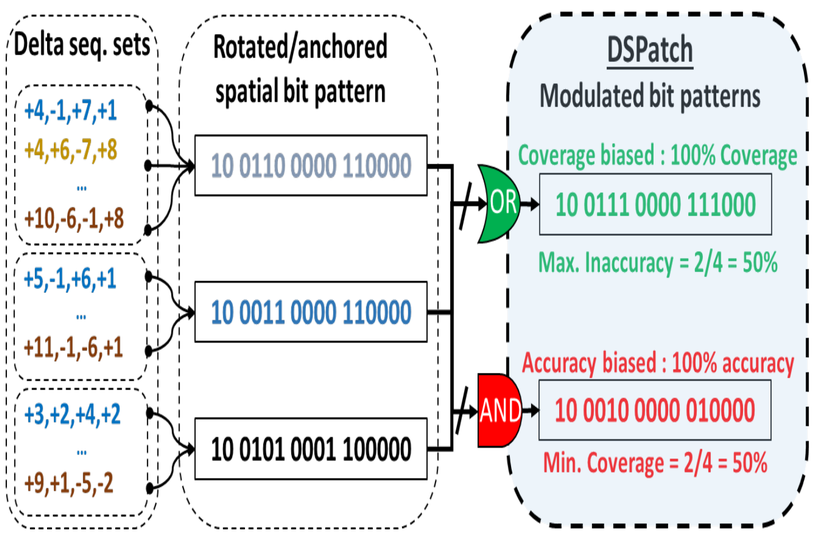
4. DSPatch Key Insights

A ***bit-pattern*** representation, ***rotated*** *and* ***anchored*** to the first "triggering" access to a page, captures all spatially identical patterns subsuming any temporal variability.

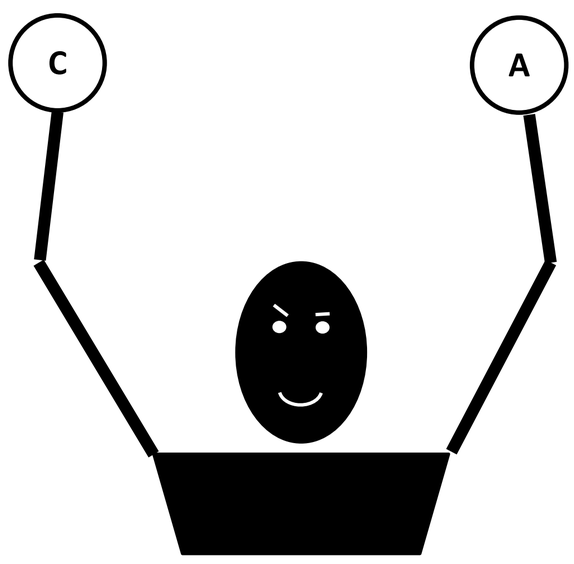
⇒ Captures all *"global deltas"* from the trigger access



- Bit-wise **OR** of rotated bit-patterns adds missing bits to the pattern, biasing it towards ***Coverage***
- Bit-wise **AND** of rotated bit-patterns keeps only repeating bits in the pattern, biasing it for ***Accuracy***

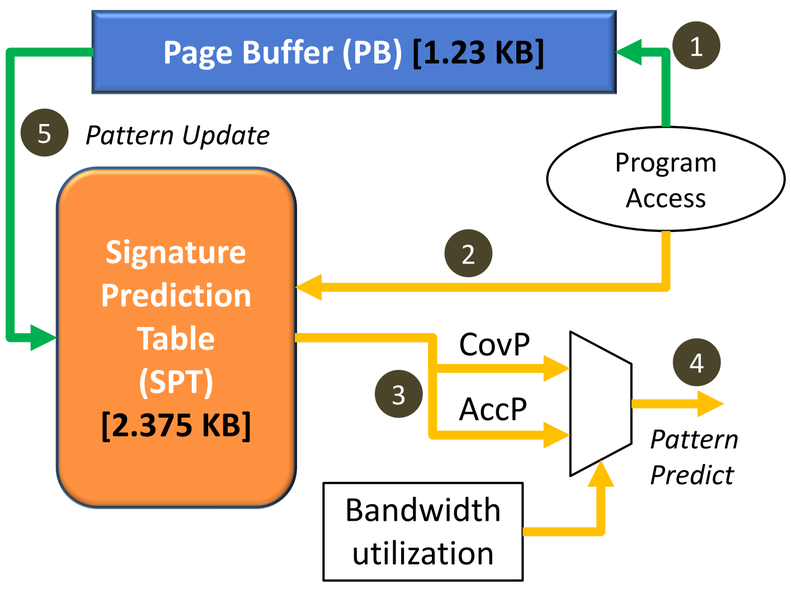


Using **dual** modulated bit-patterns allows ***DSPatch*** to simultaneously optimize for *both* ***Coverage*** *and* ***Accuracy***



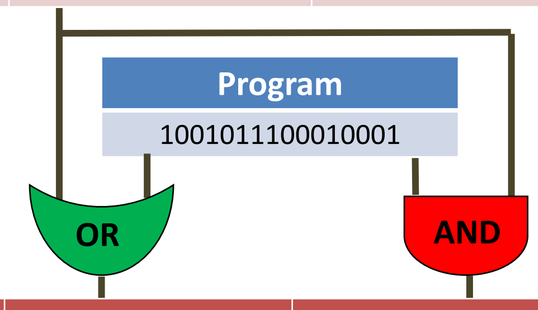
5. DSPatch Design

DSPatch: Overall Flow



DSPatch: Pattern Update

PC Signature	CovP	AccP
0x7ffecca	1100011001111100	1000001000011000

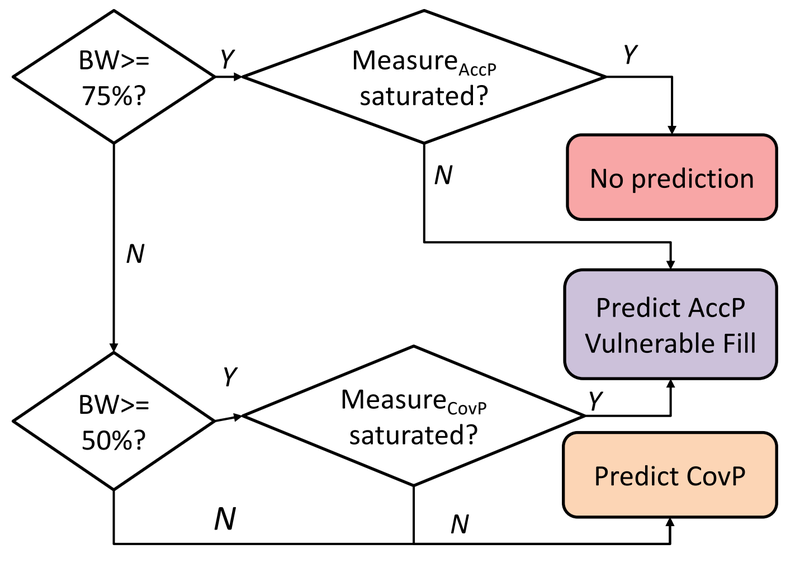


PC Signature	CovP	AccP
0x7ffecca	1101111101111101	1000001000010000

Measure$_{CovP}$ **: Incr. if CovP Coverage < 50% || CovP Accuracy < 50%**

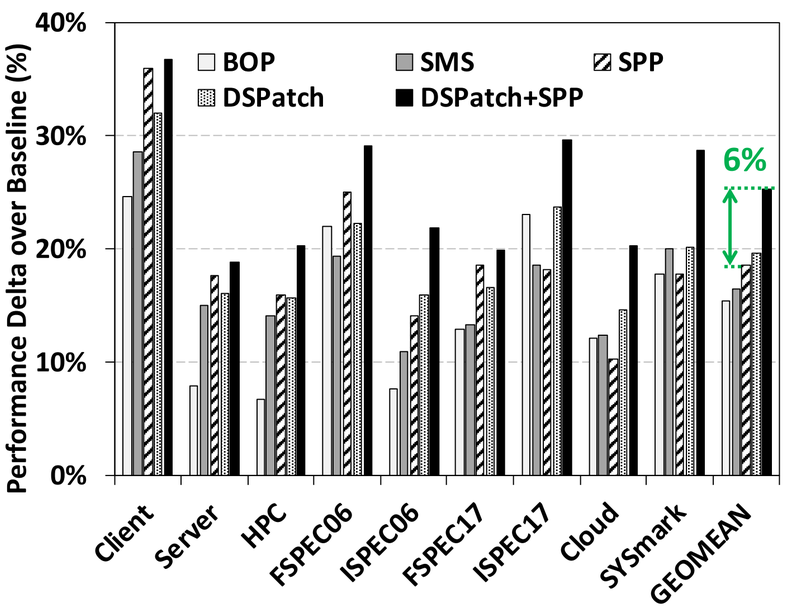
Measure$_{AccP}$ **: Incr. if AccP Accuracy < 50%**

DSPatch: Pattern Predict

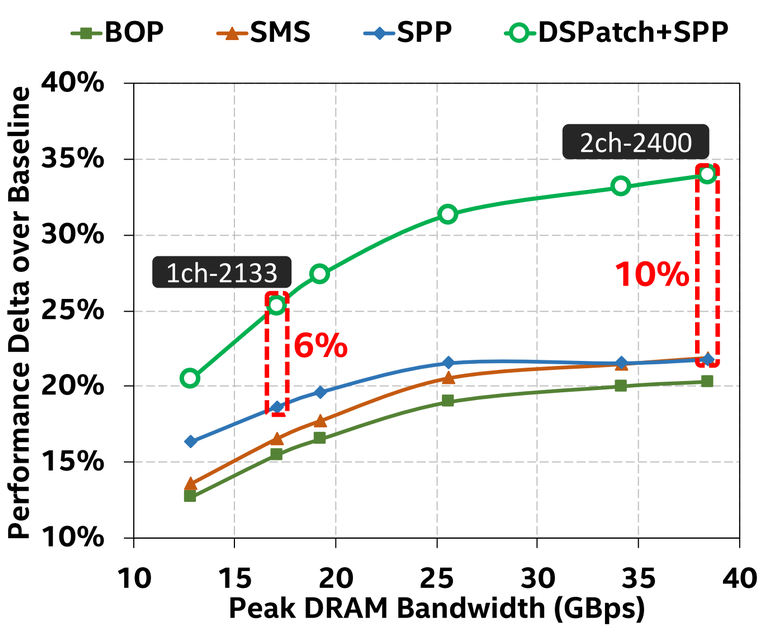


5. DSPatch Results

DSPatch: Single Core Performance



DSPatch: Single Core DRAM B/W Scaling



DSPatch: Multi-Core Performance