Wormhole branch prediction using multi-dimensional histories

Jorge Albericio,
Joshua San Miguel,
Natalie Enright Jerger, and Andreas Moshovos


14
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1 | 4

Motivation

foreach frame:
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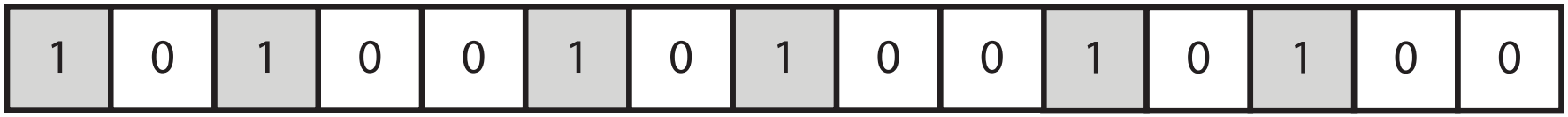


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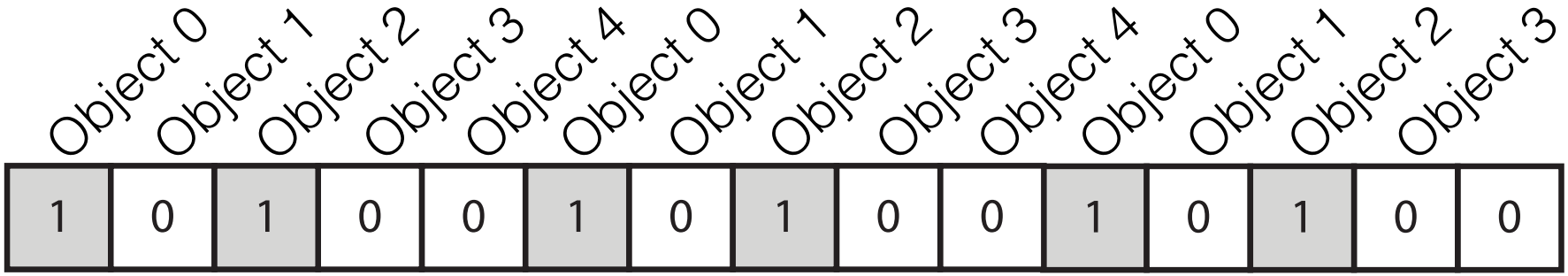


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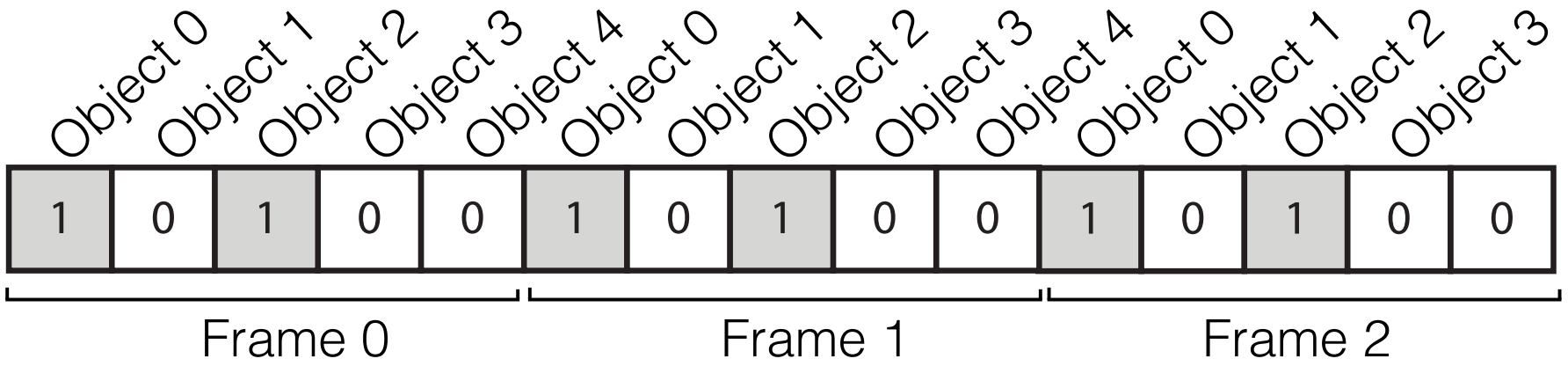


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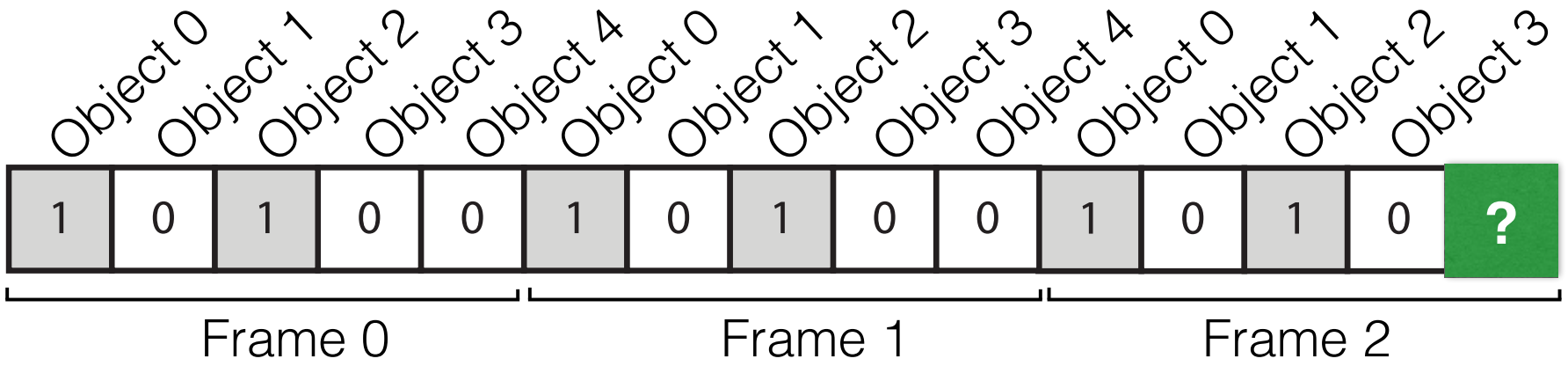


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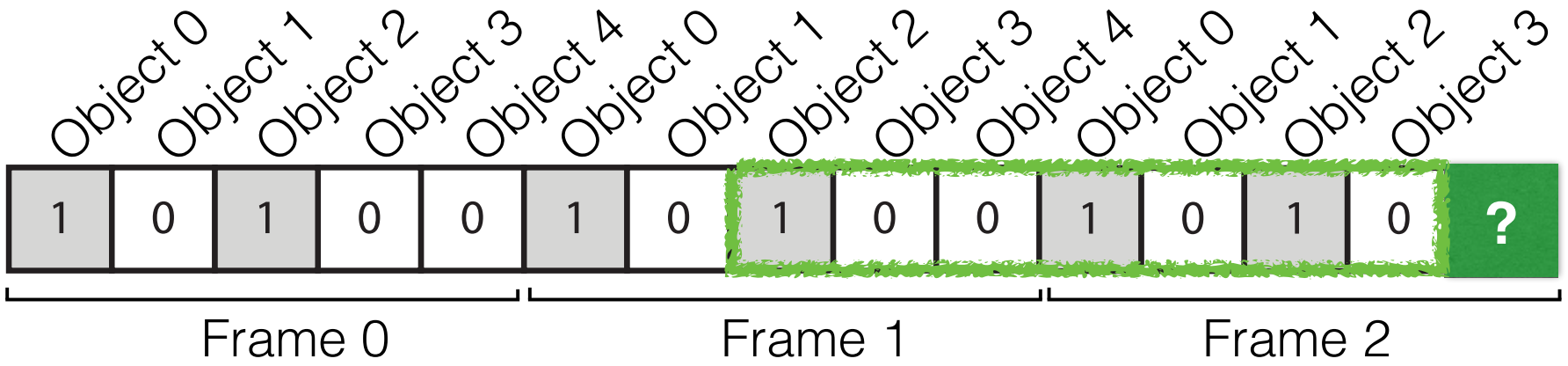


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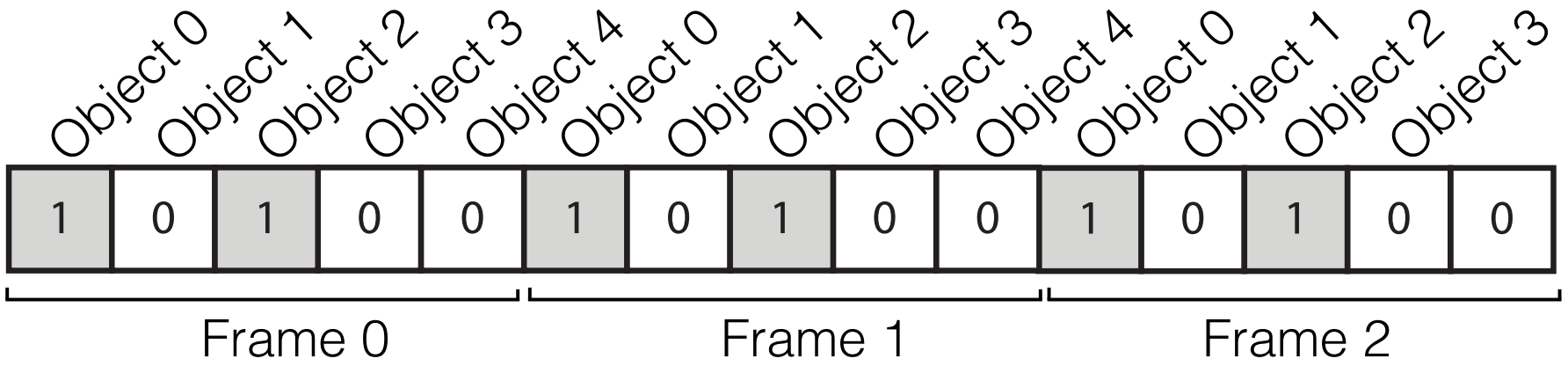


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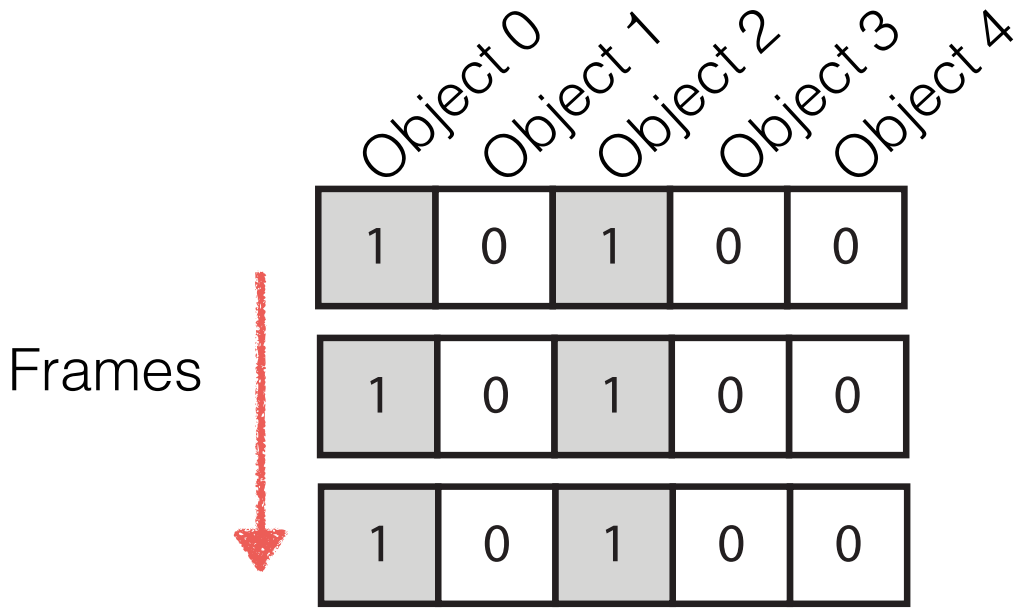


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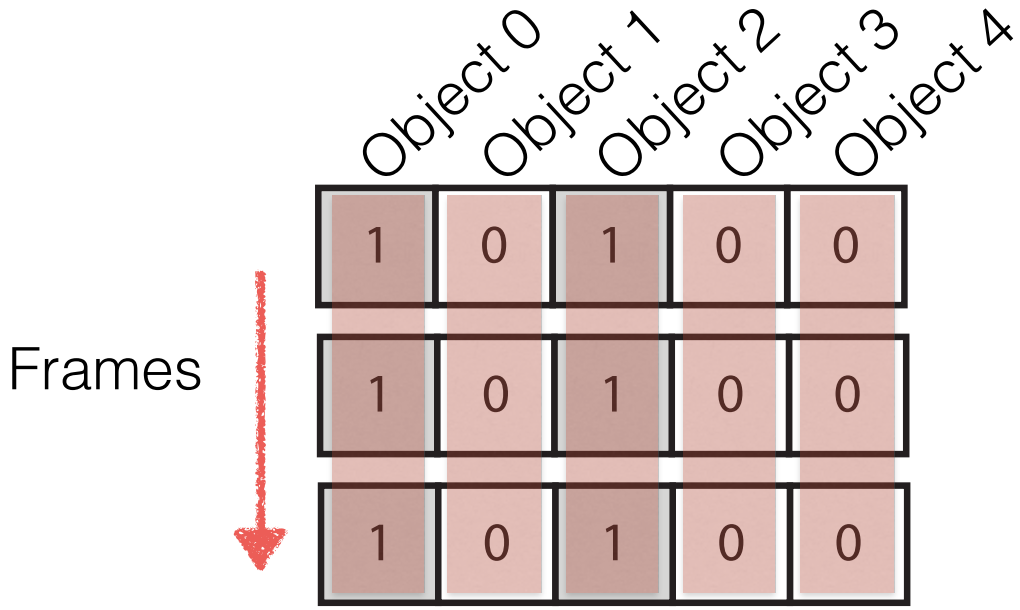


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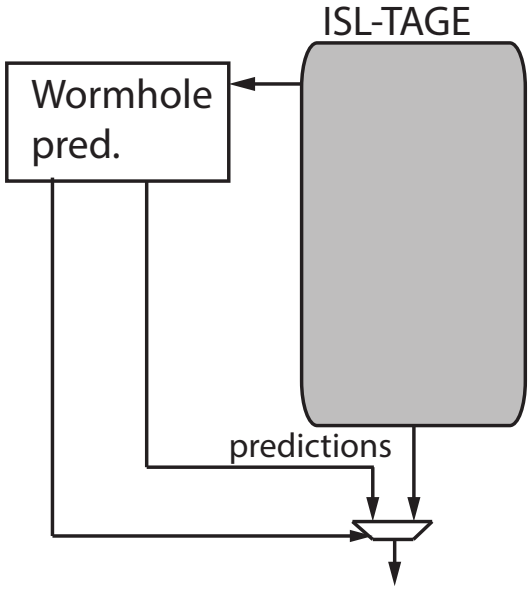
Summary

- **Wormhole predictor**: Side-predictor on top of ISL-TAGE
- Able to capture columns, diagonals, and other patterns
- **3.995**, **2.498**, and **2.014** MPKI in the 4KB, 32KB, and unlimited competition tracks



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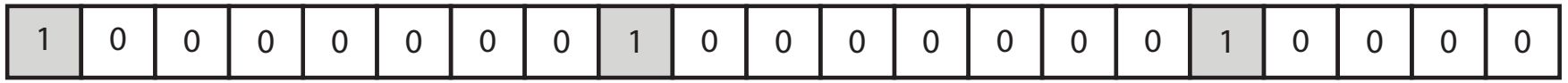

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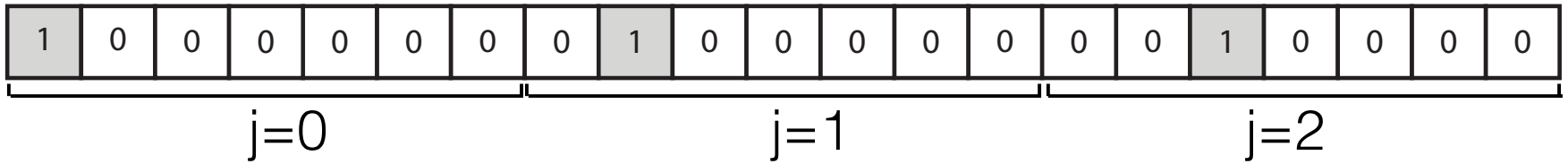

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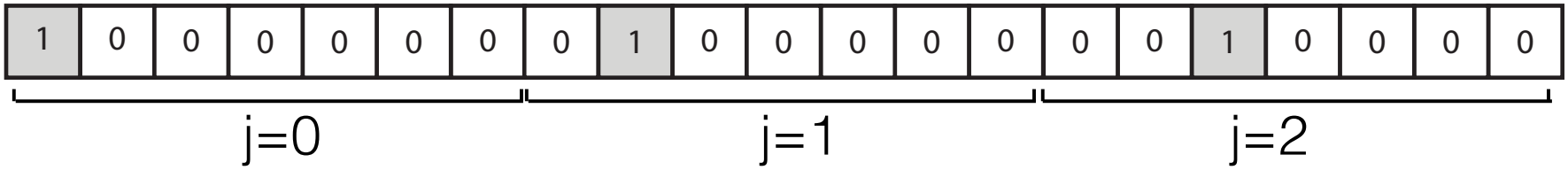


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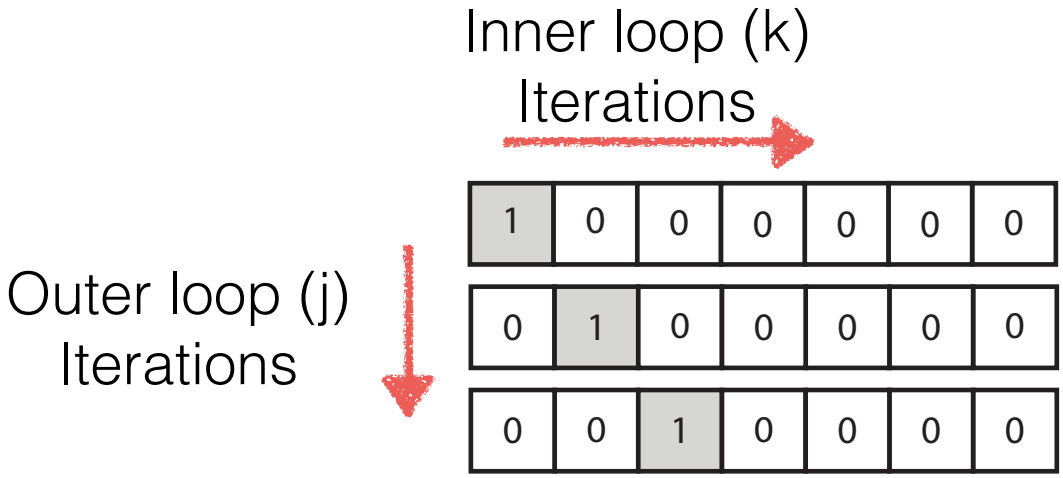


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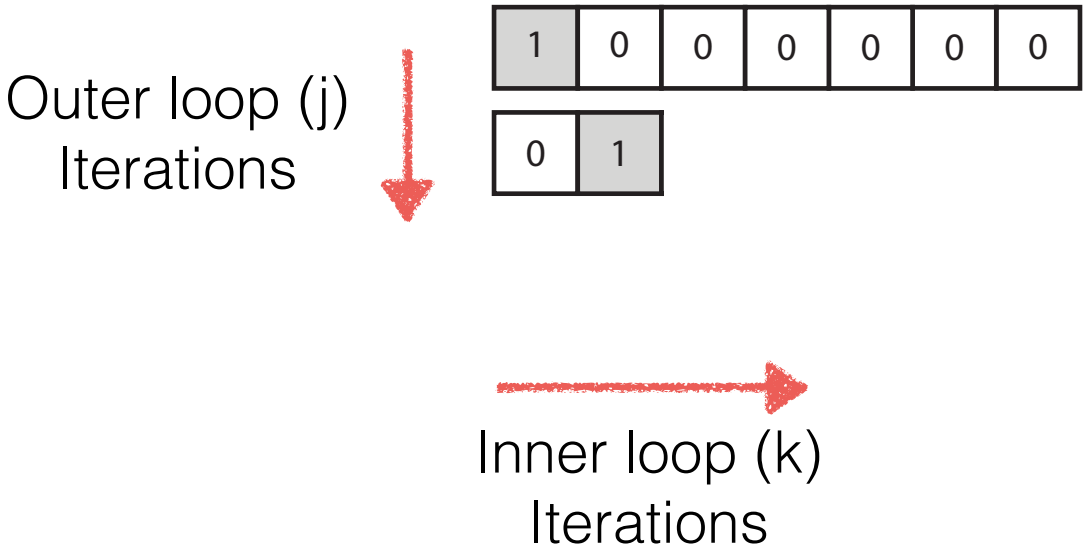


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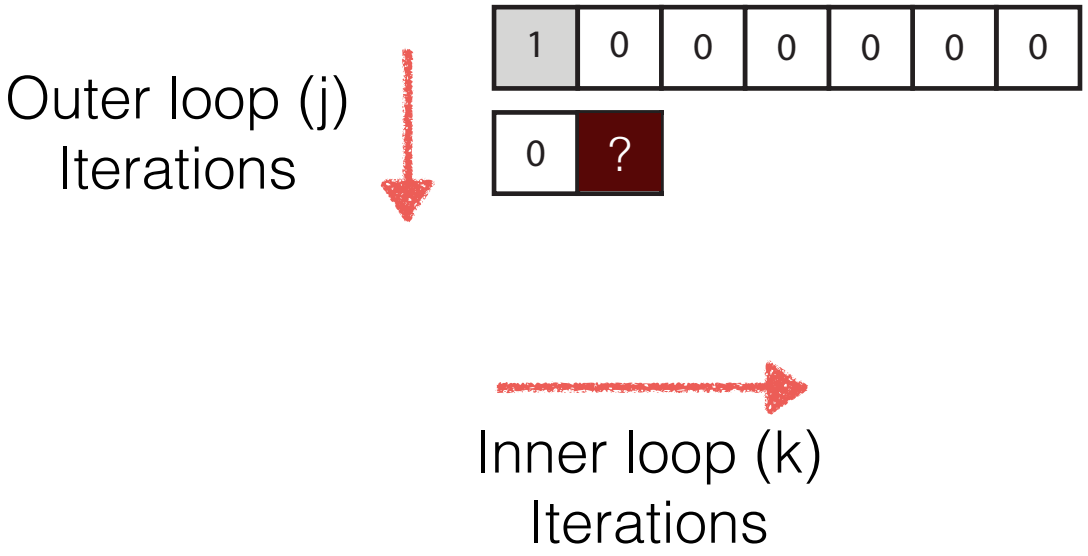


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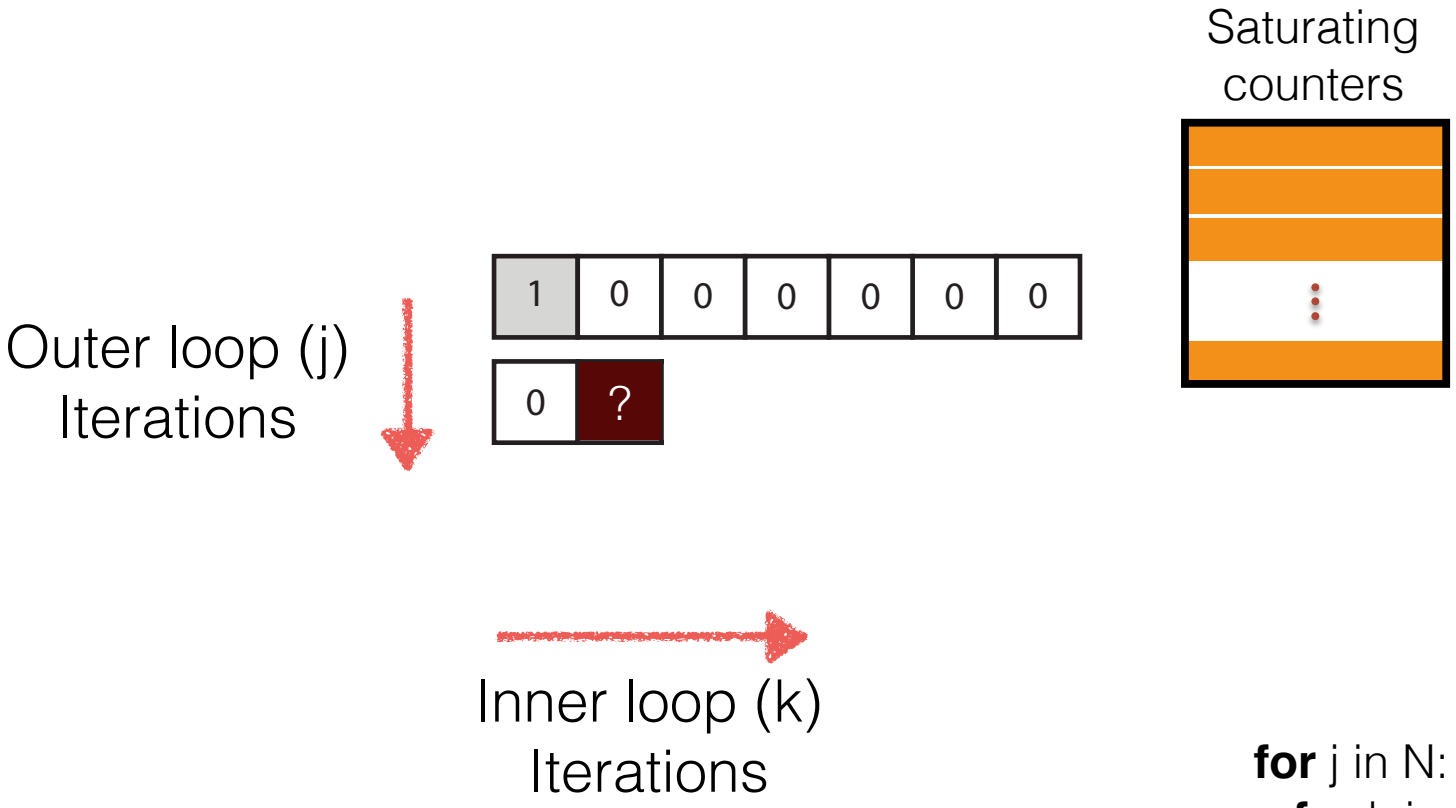


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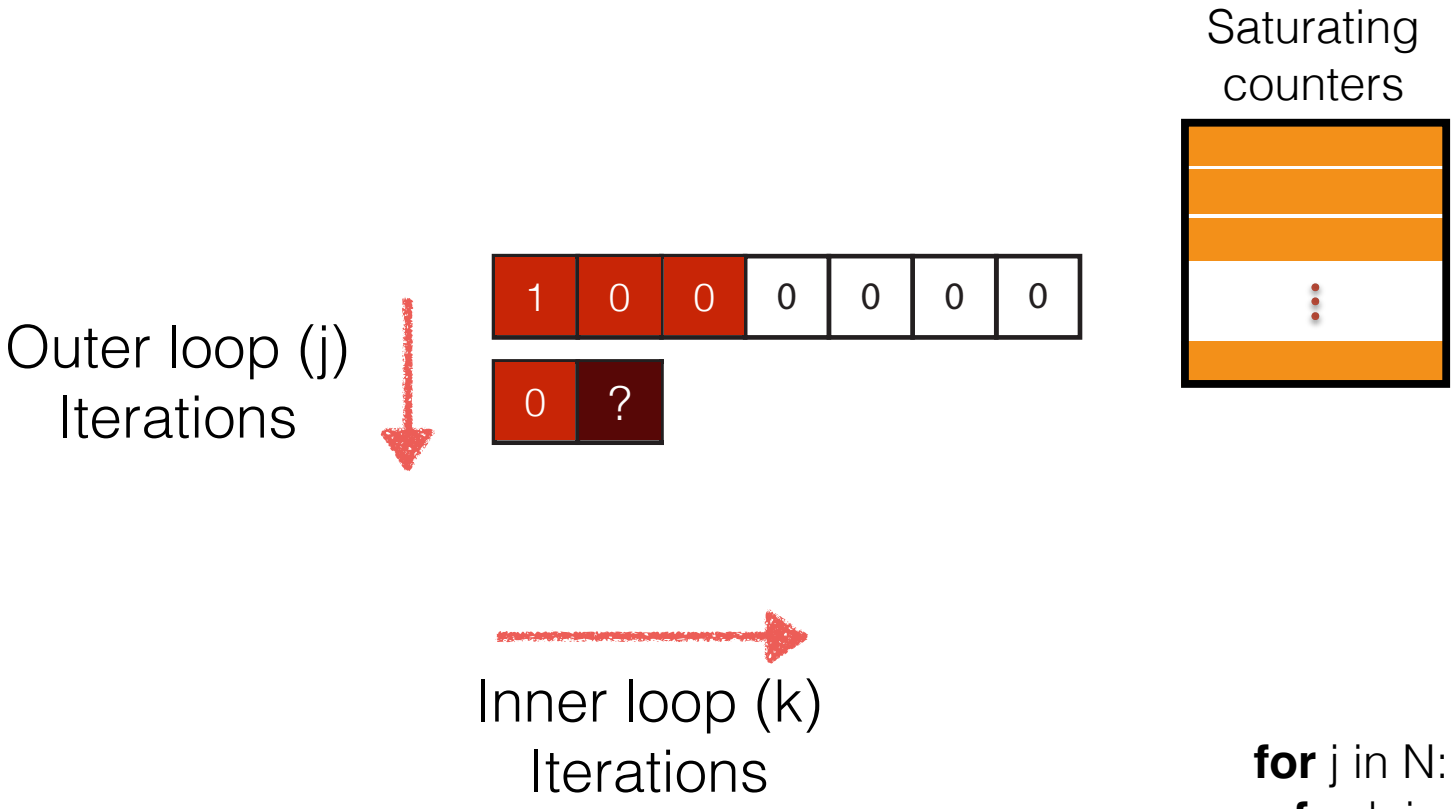


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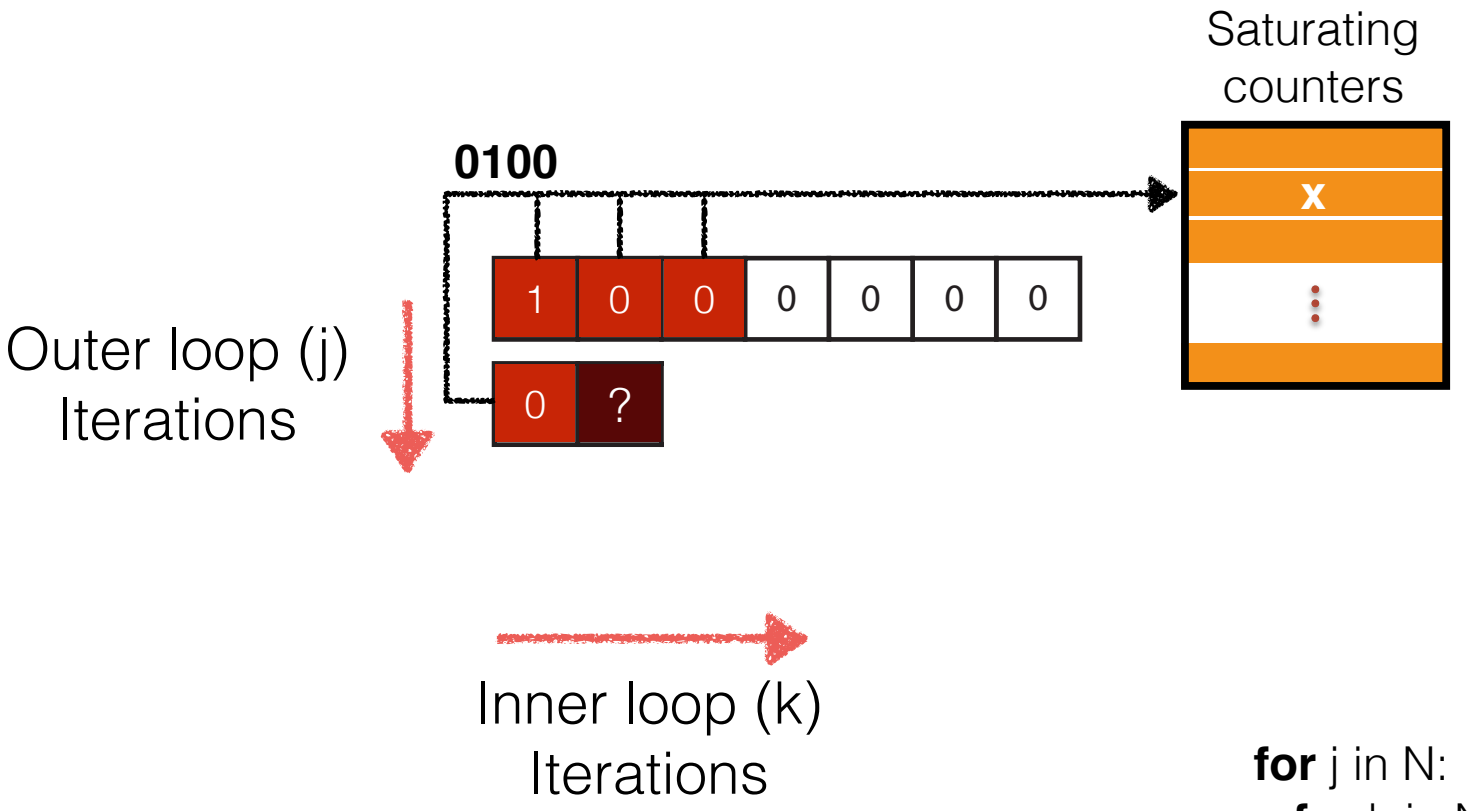


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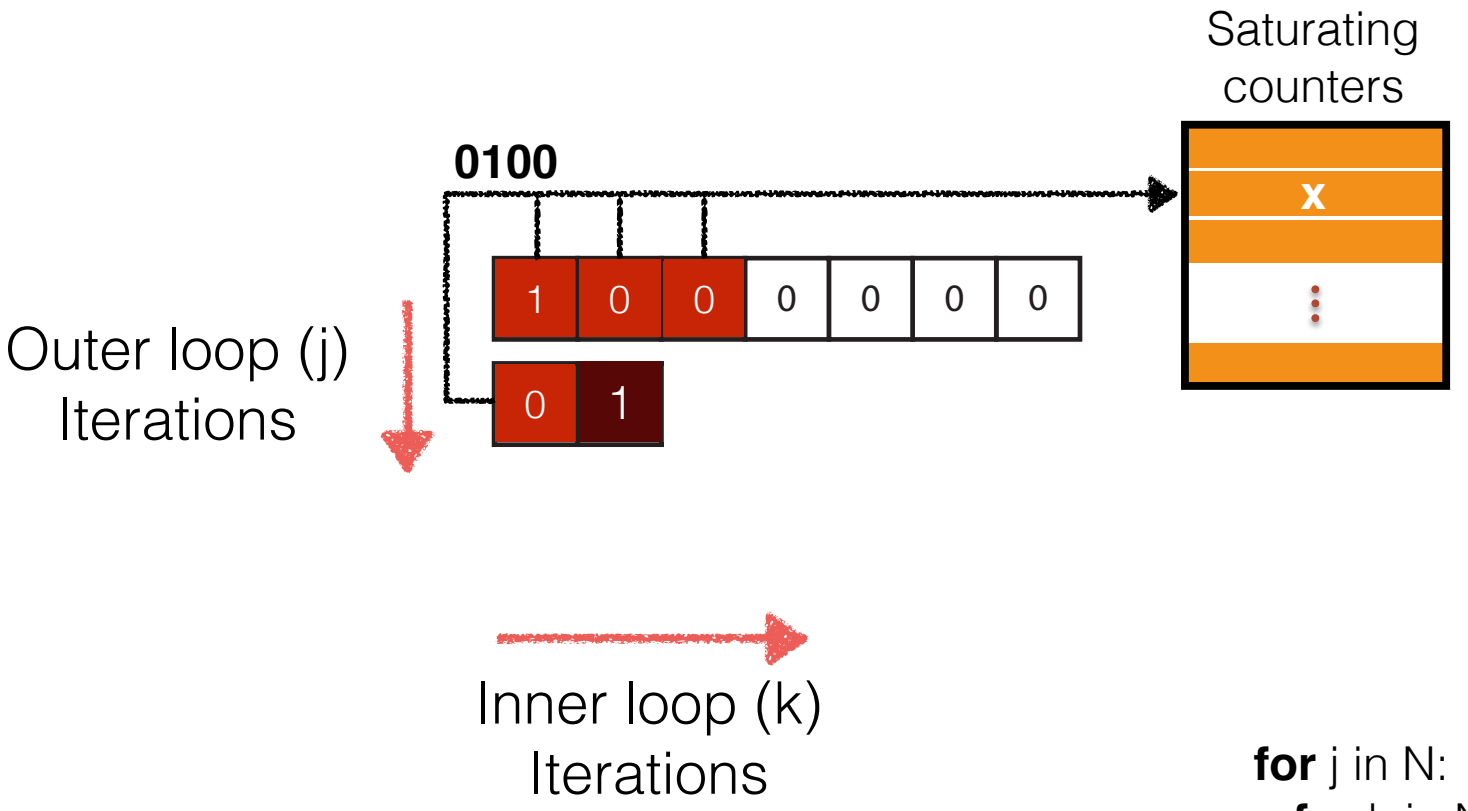


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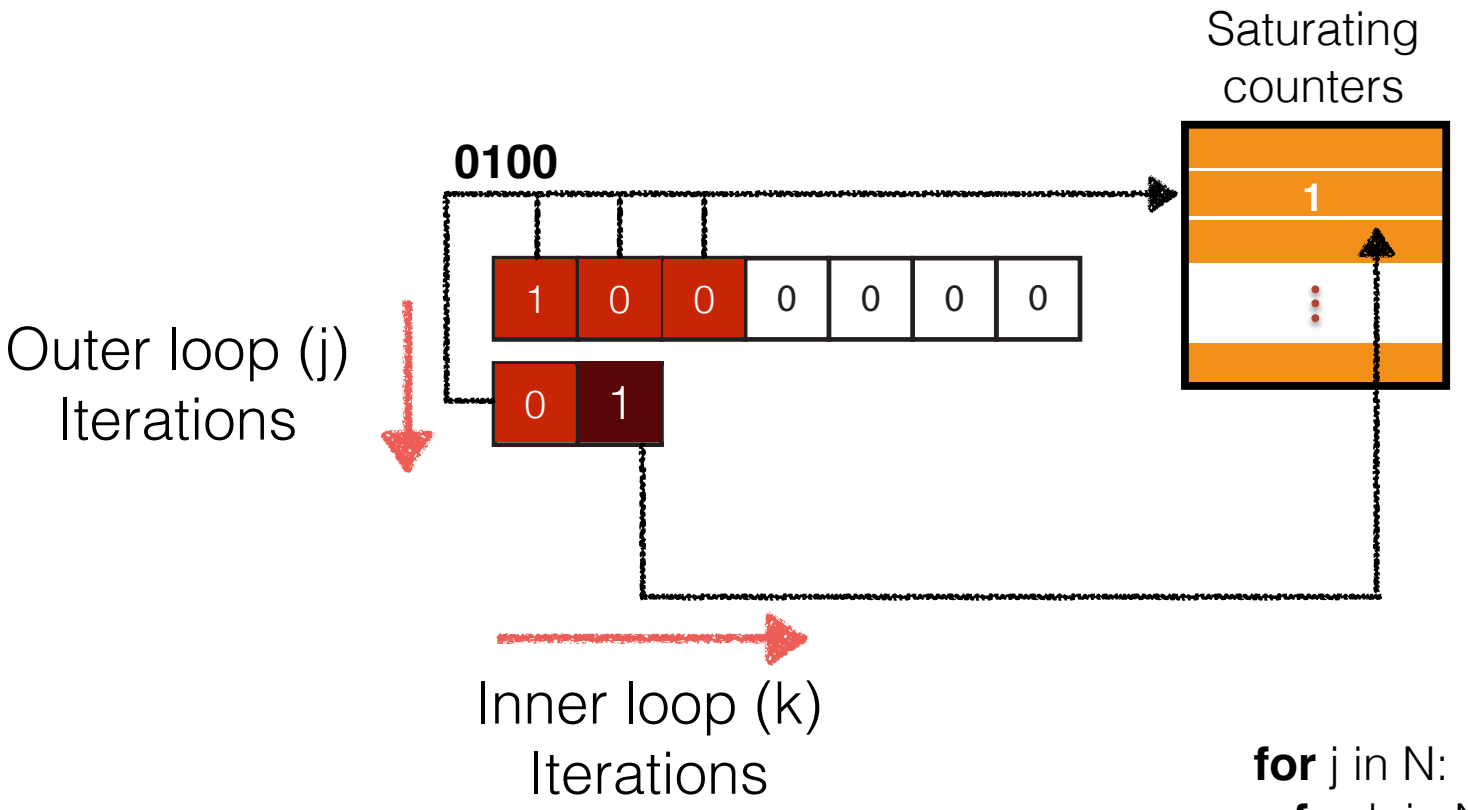


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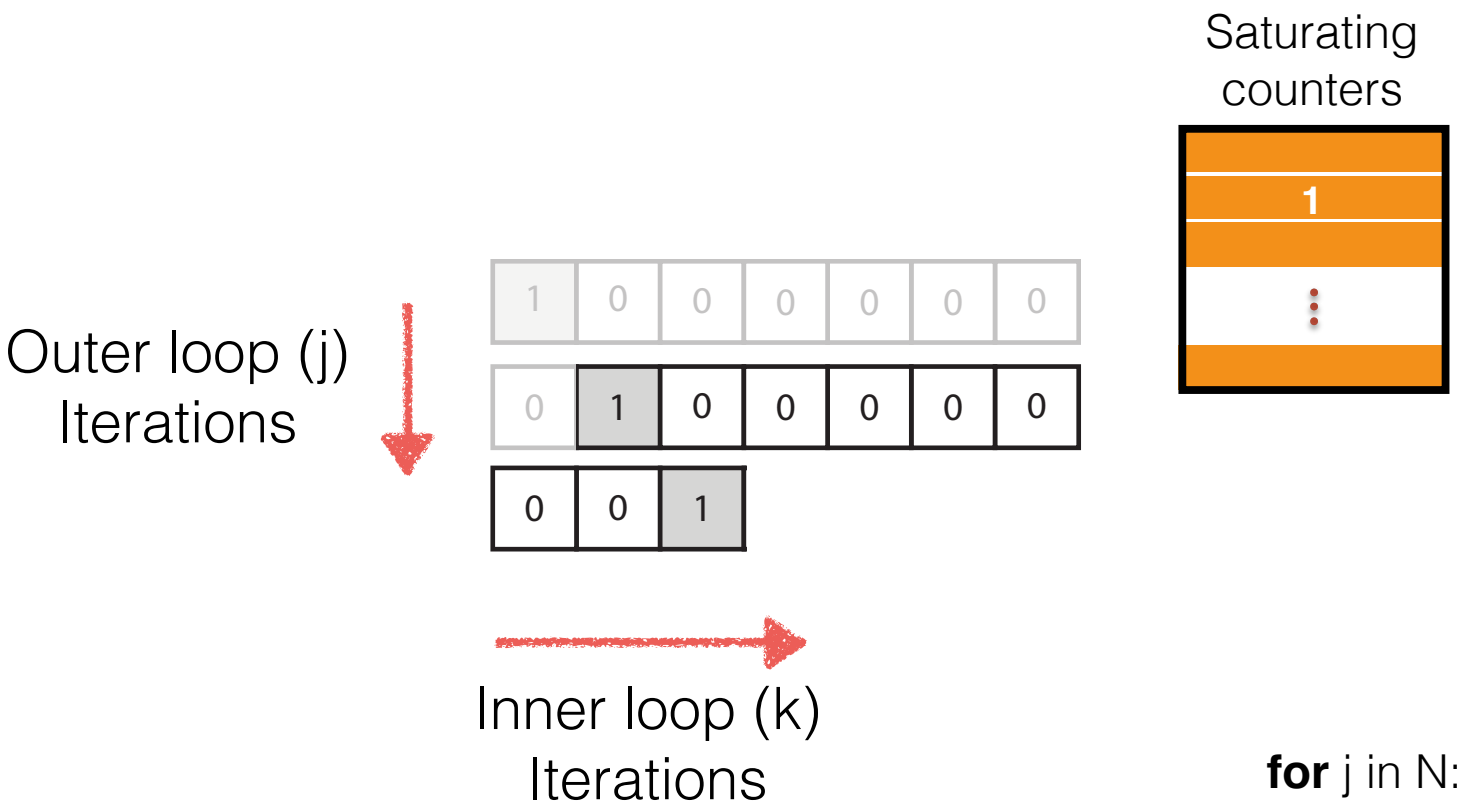


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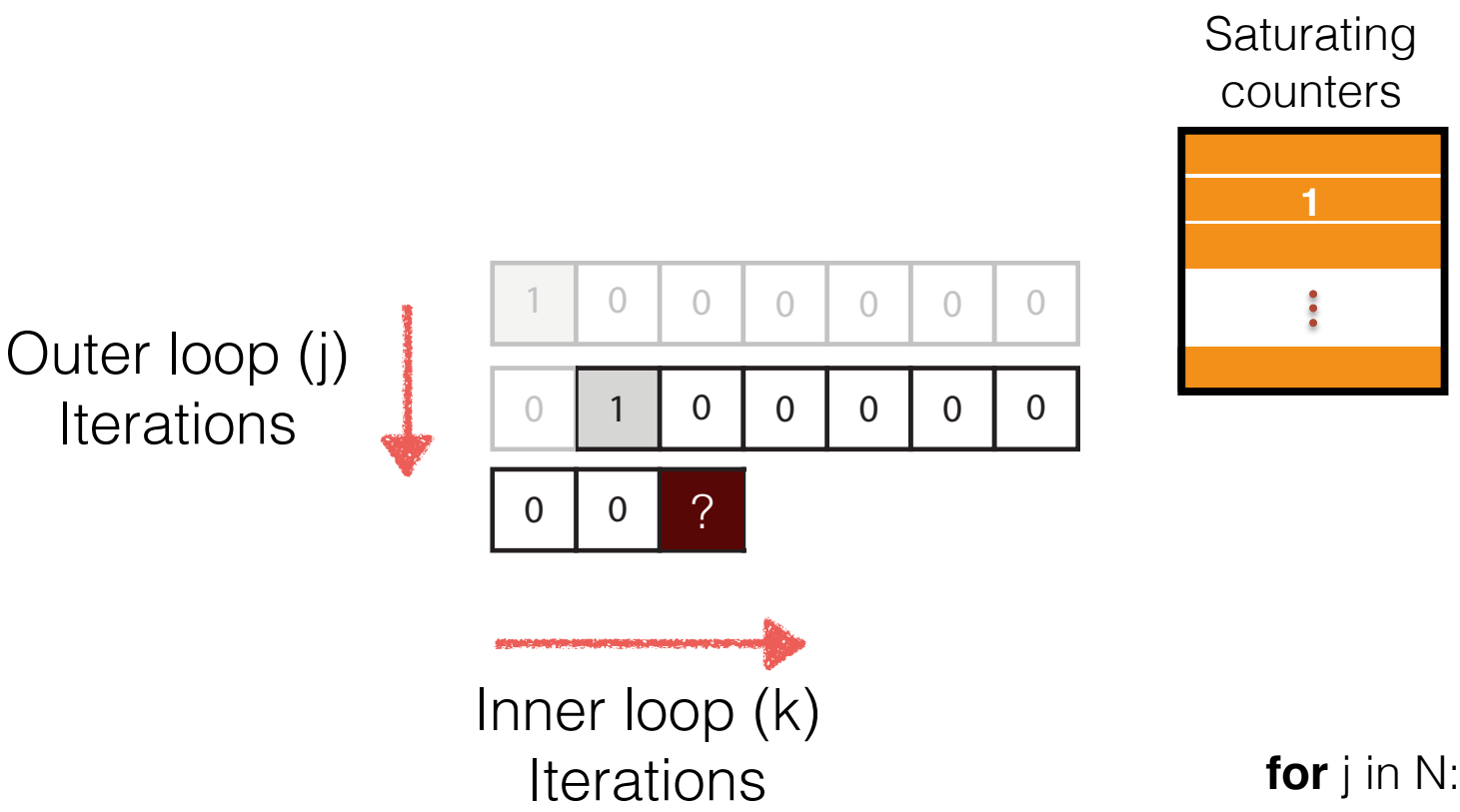


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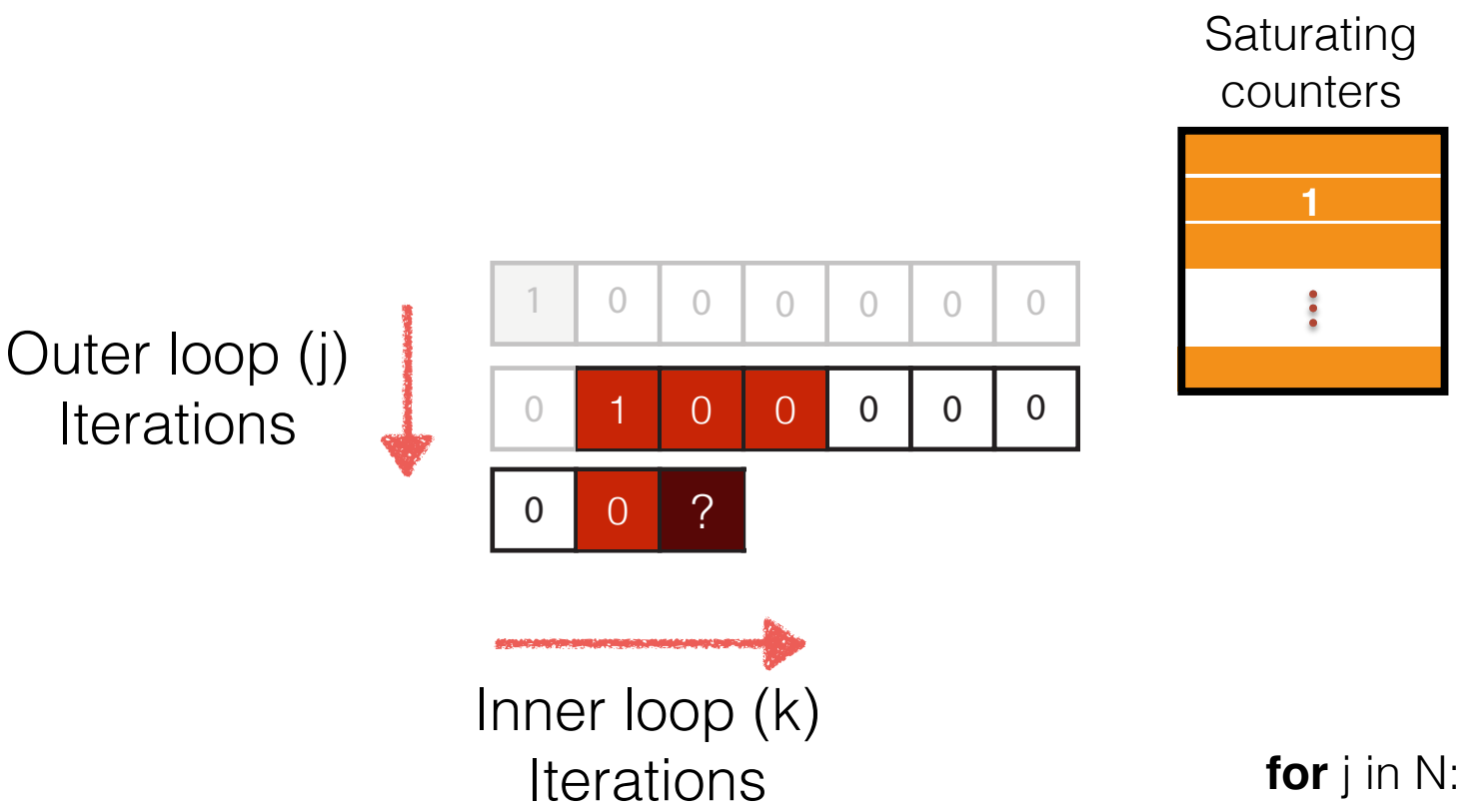


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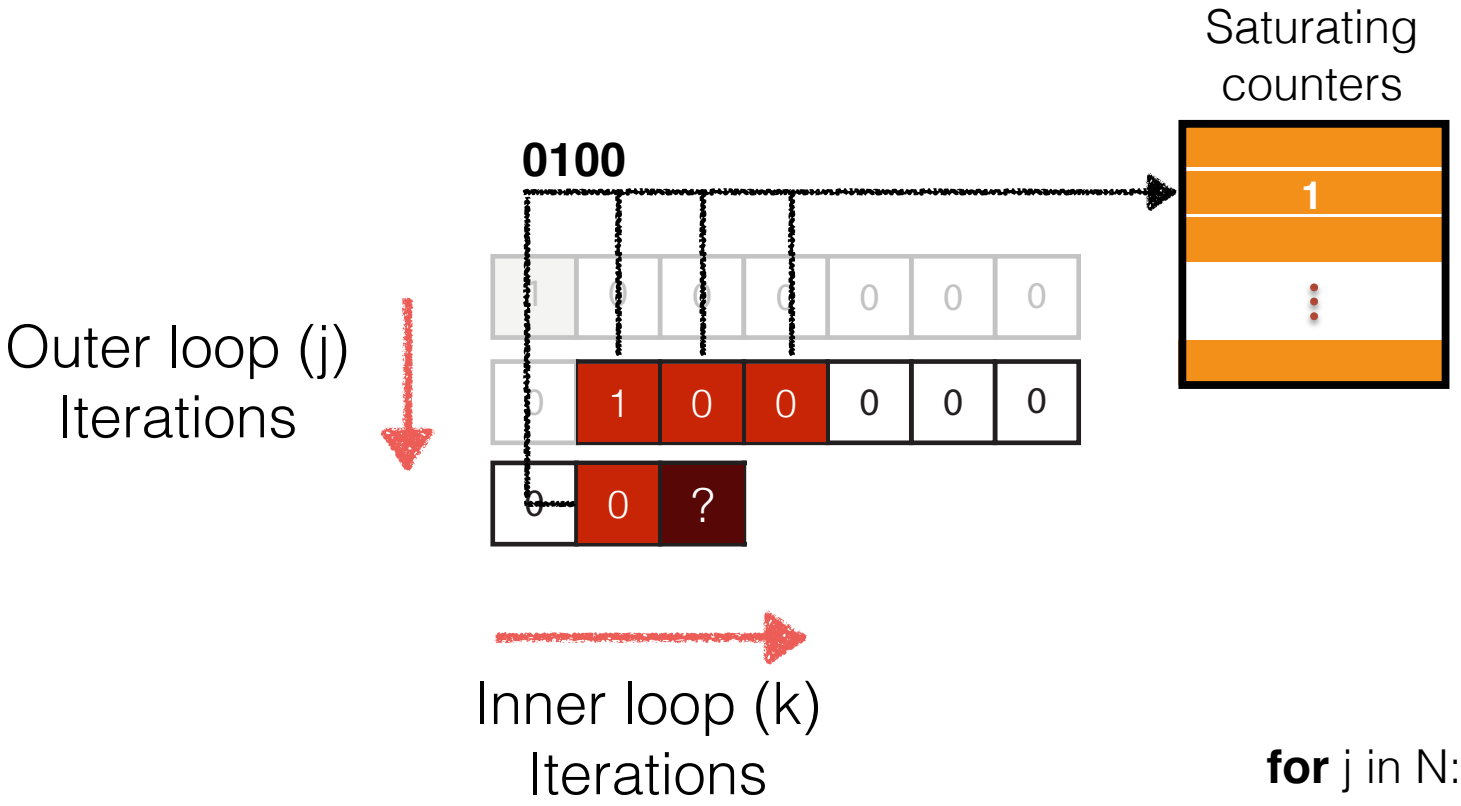


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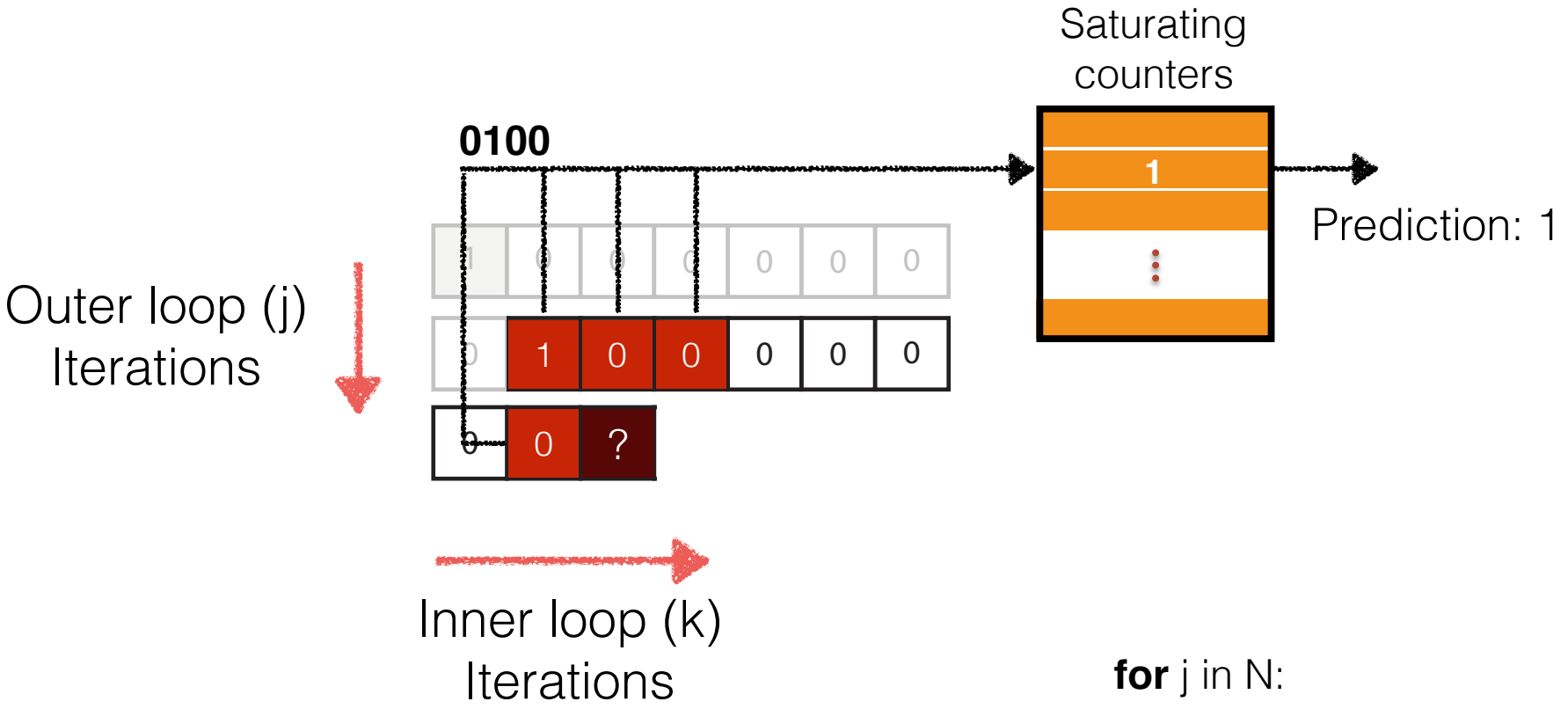


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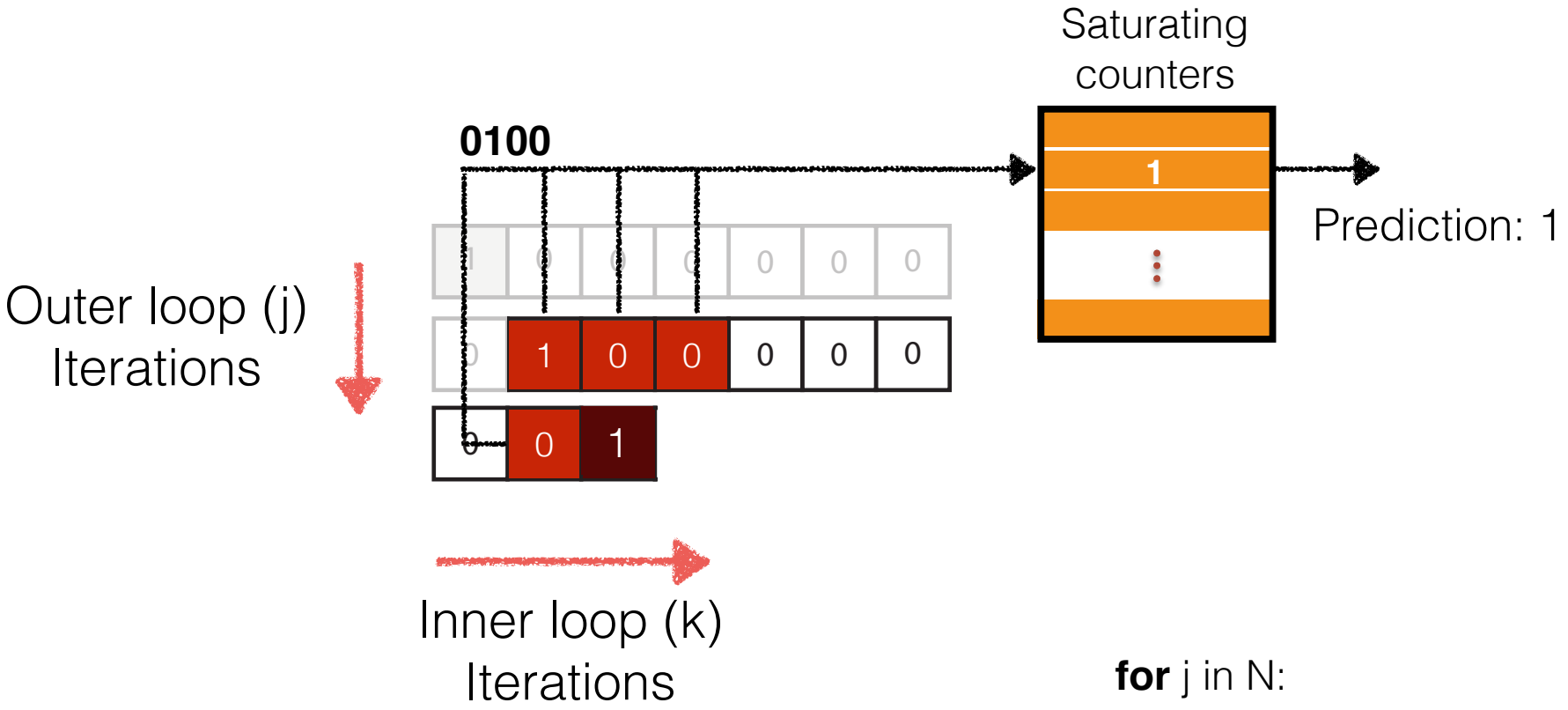


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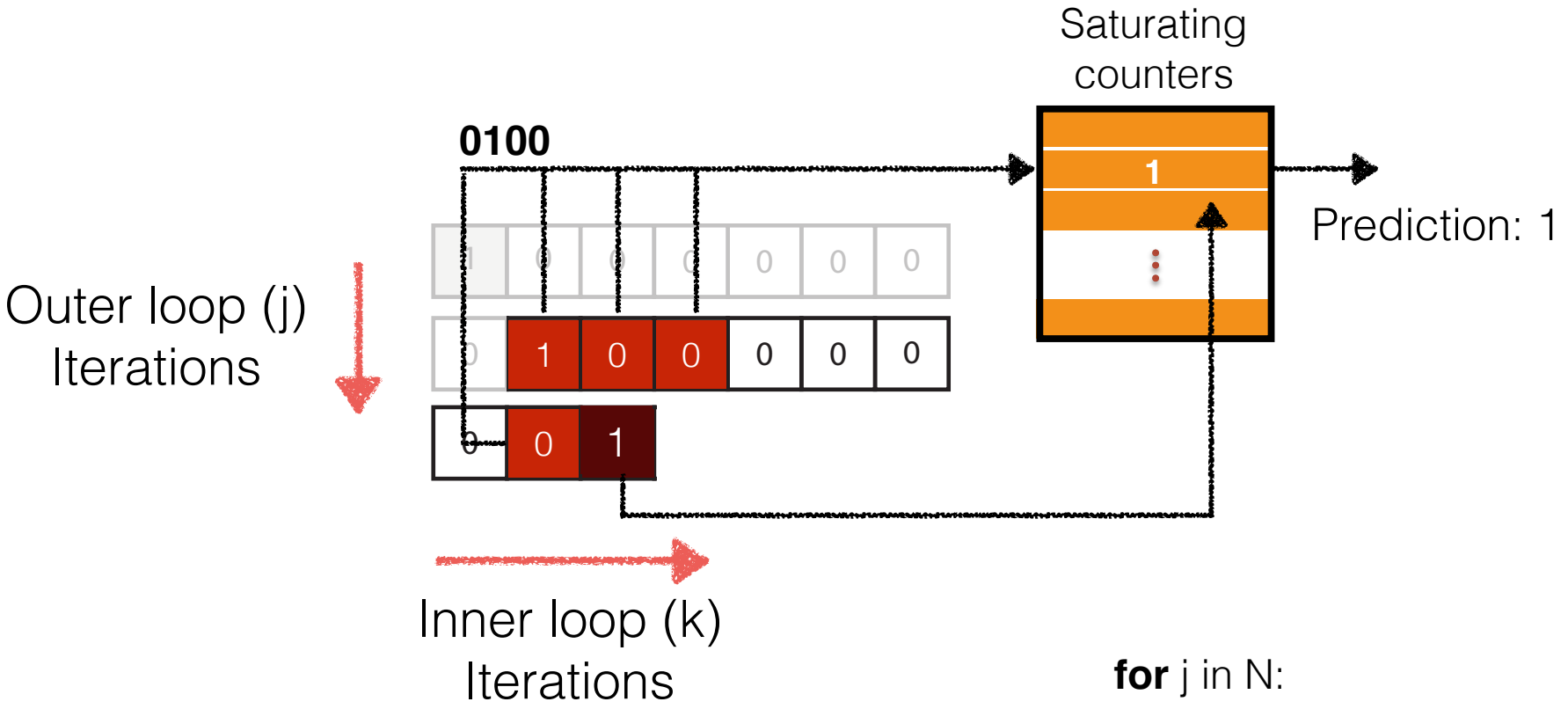


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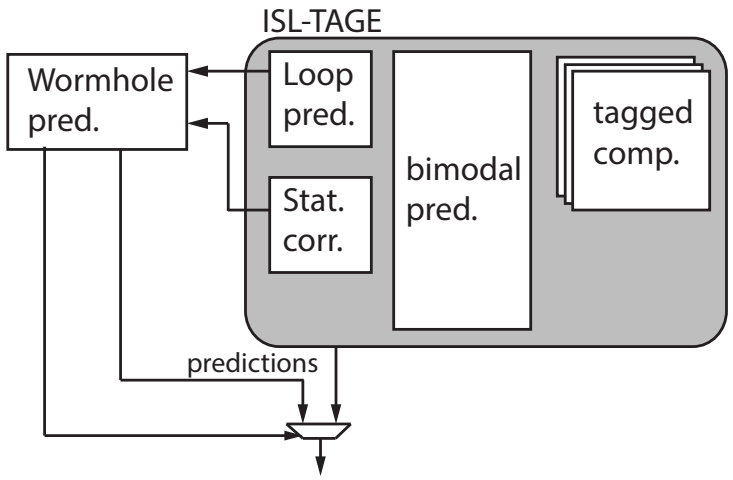
Wormhole predictor and ISL-TAGE

- On top of ISL-TAGE
  (Best performer from last CBP)
  - TAGE: bimodal + tagged
  - Statistical corrector
  - Loop predictor



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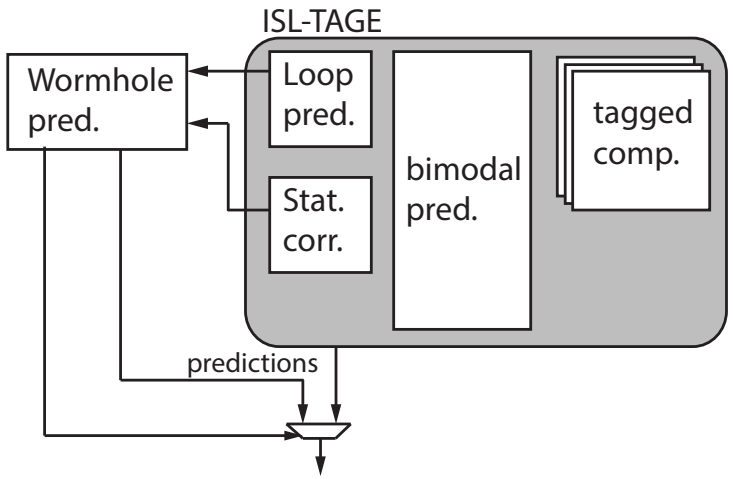

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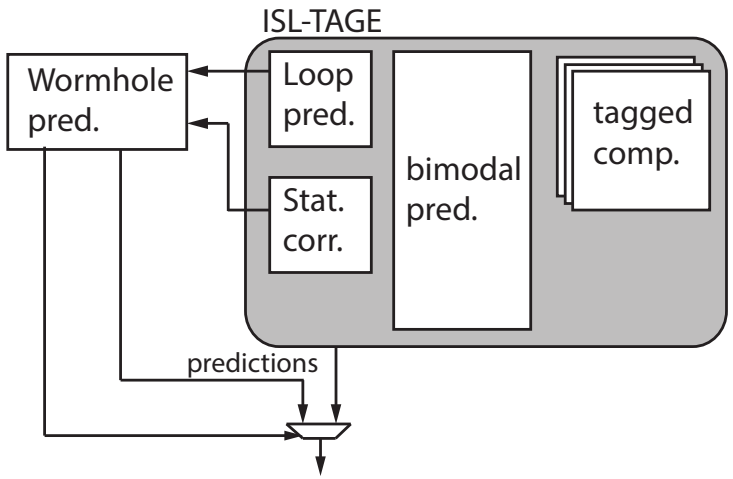
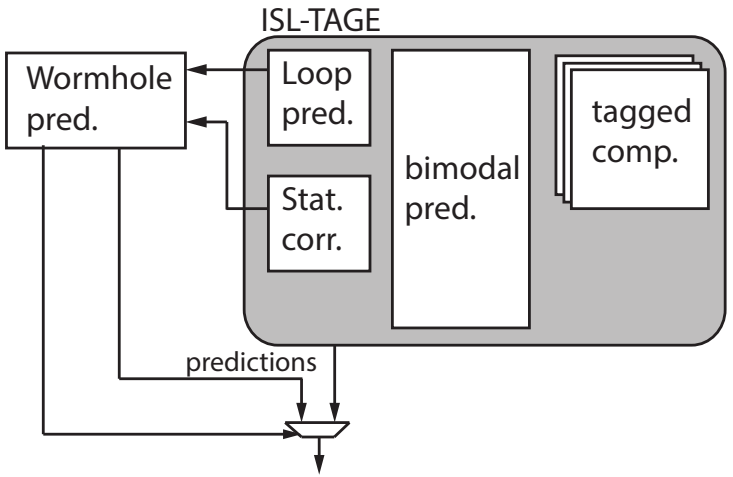


Detect difficult branches

Loop dimensionality

ISL-TAGE

- **Difficult branches**
  - Statistical corrector calculates accuracy for TAGE
  - Wormhole allocates when low accuracy
- **Loop dimensionality**
  - Stored at *LP_iters*
- ***u* field (4KB)**
  - 3 bits
  - Updated when “as in the original TAGE”
  - Not reset: Incremented and decremented



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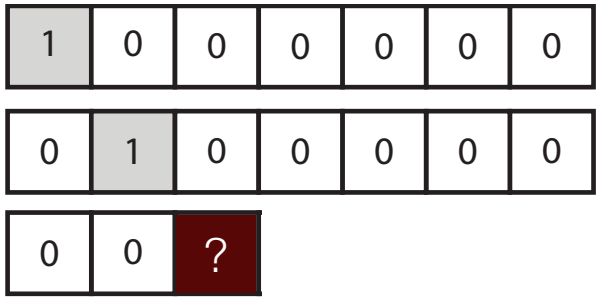

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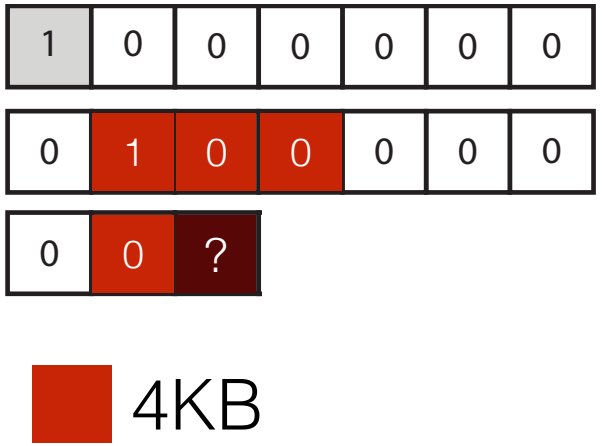

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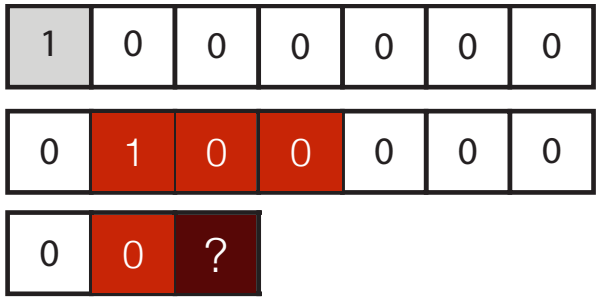

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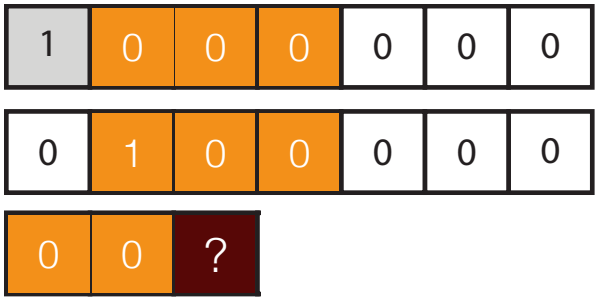

32KB & Unlim.

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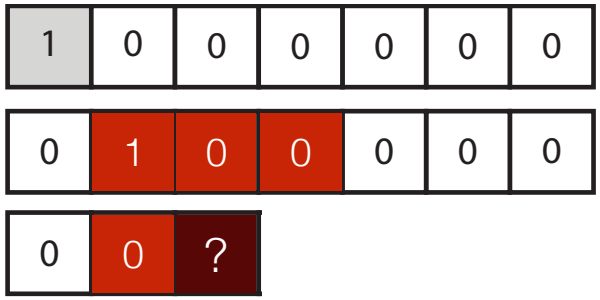

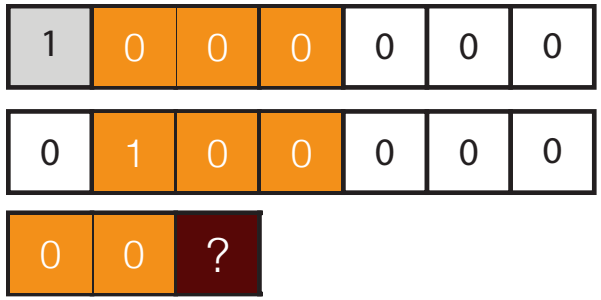

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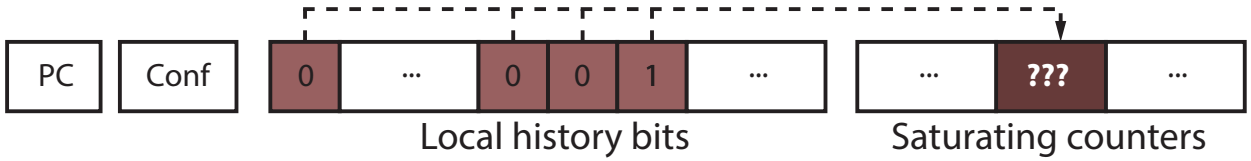

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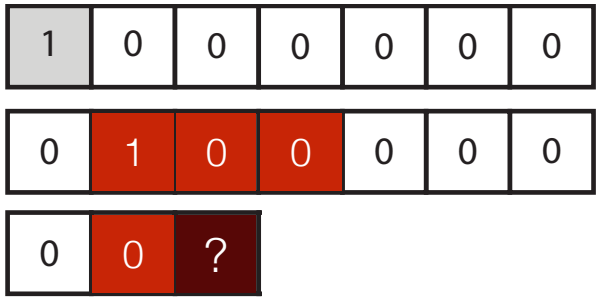

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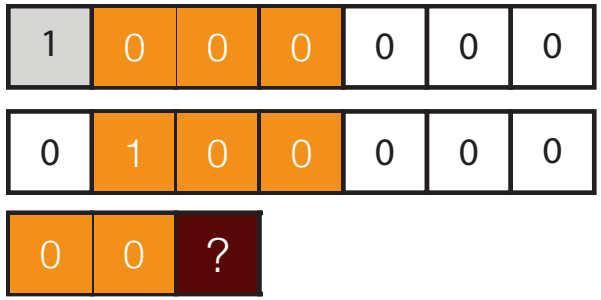

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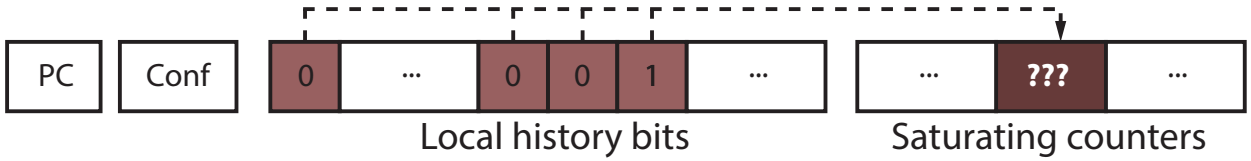

4KB:	18	4	101	16 x 5
32KB & Unlim.:	18	4	301	256 x 5

(bits)

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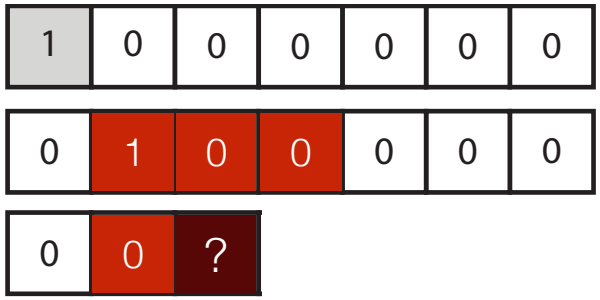

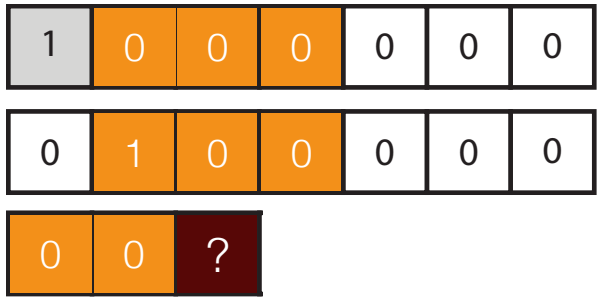

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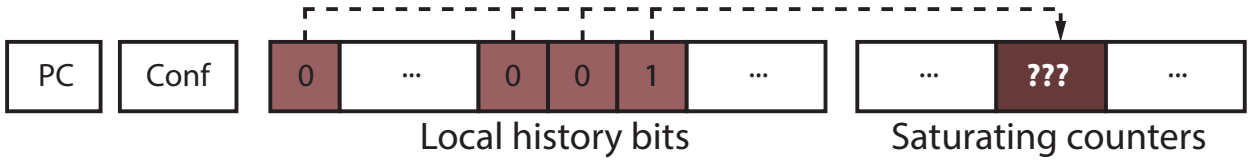

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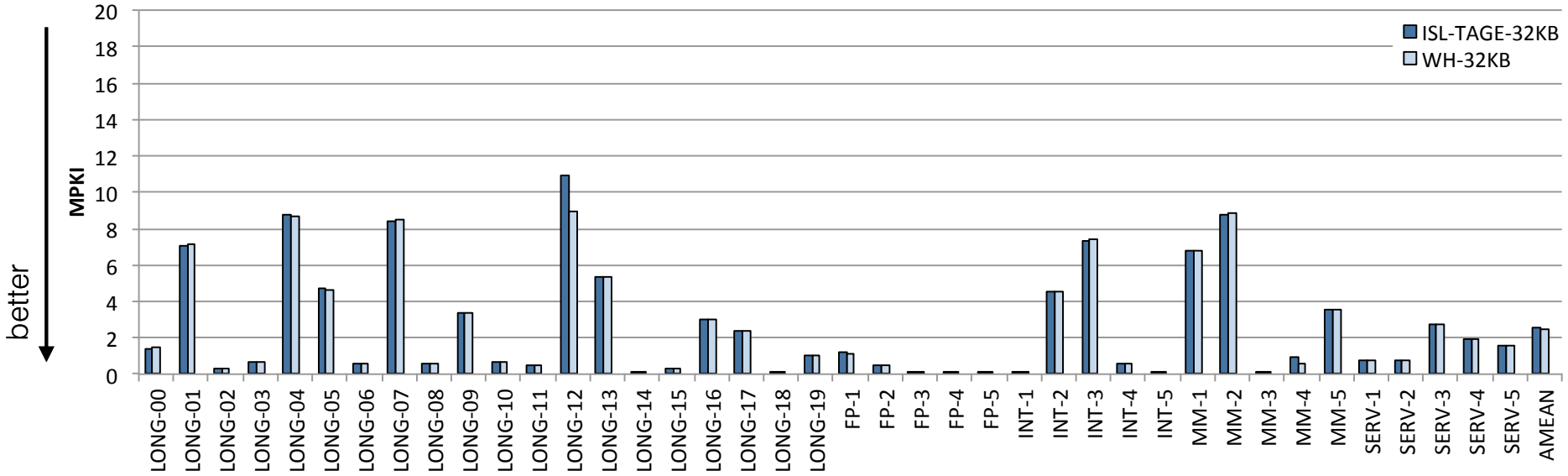
32KB & Unlim.:	18	4	301	256 x 5	= 1615

Results: 32KB



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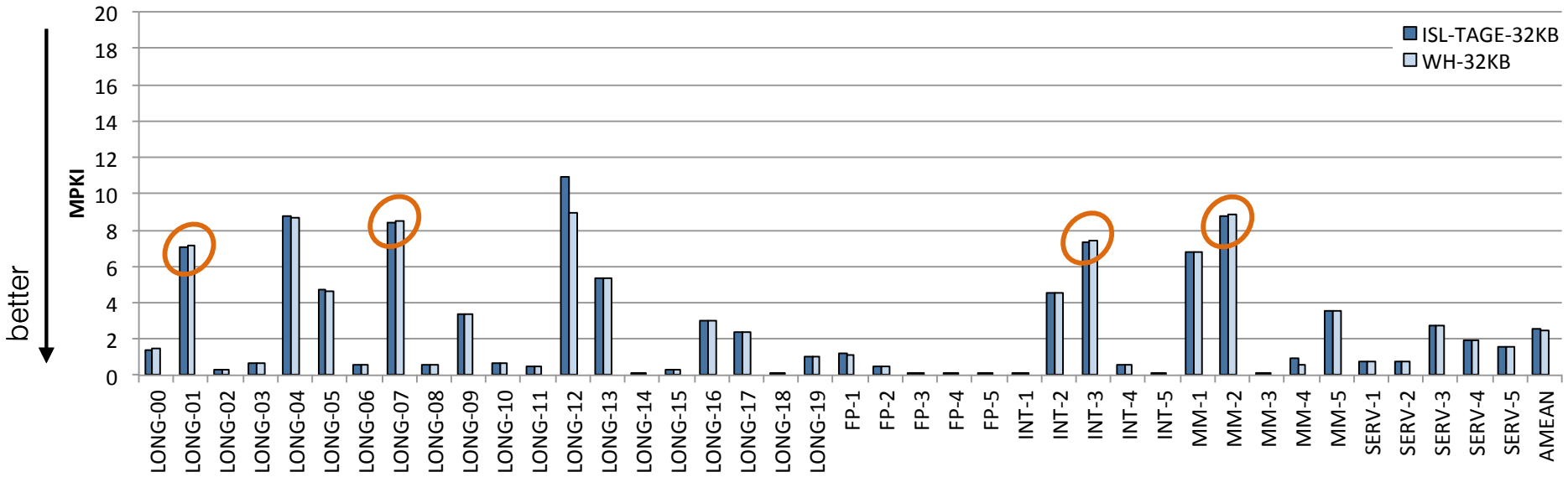

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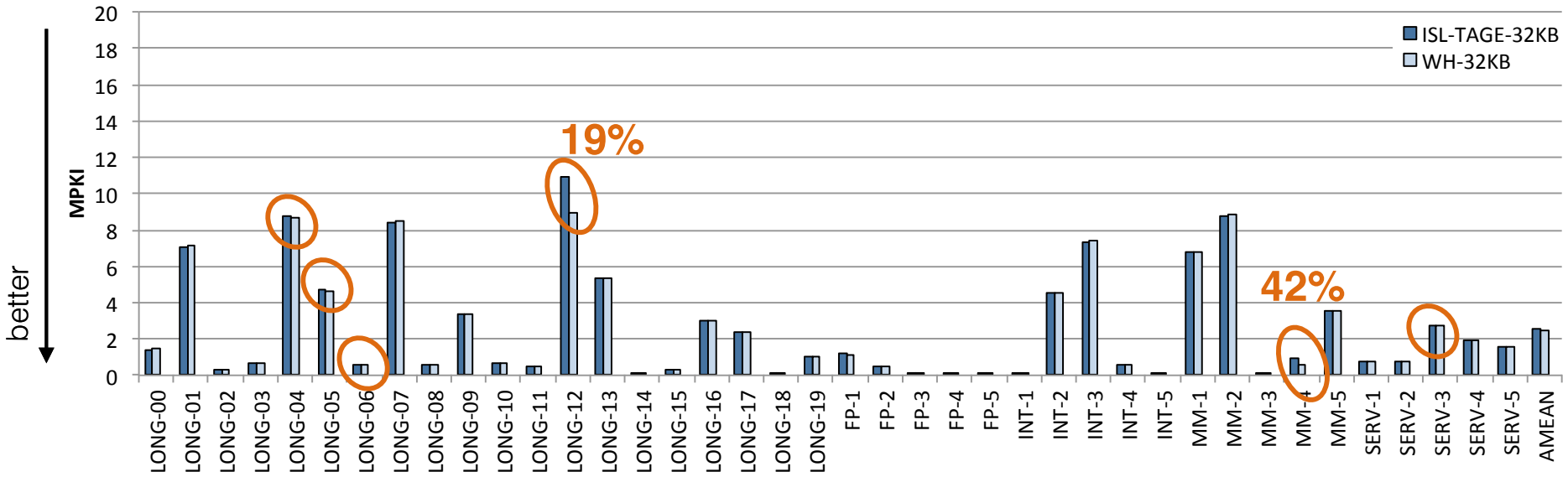
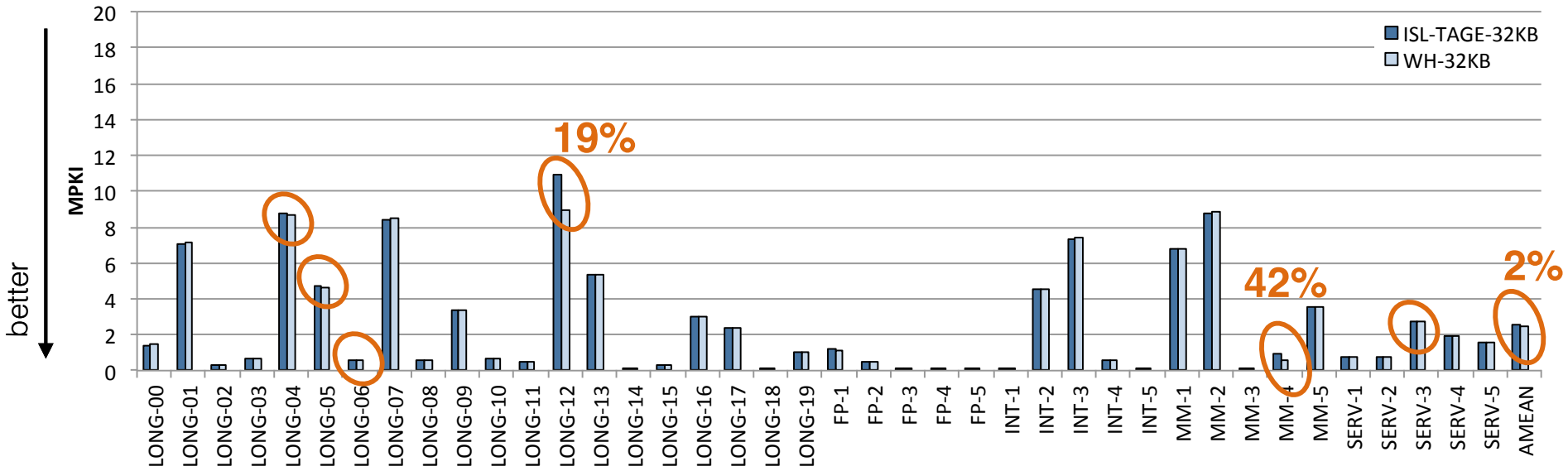
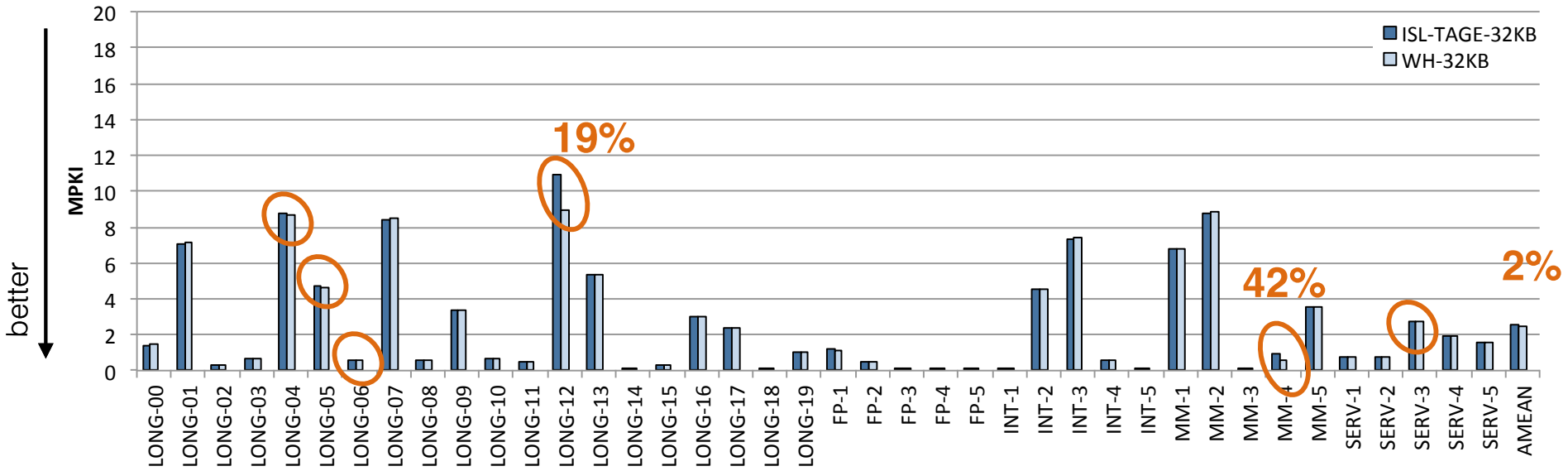


Results: 32KB



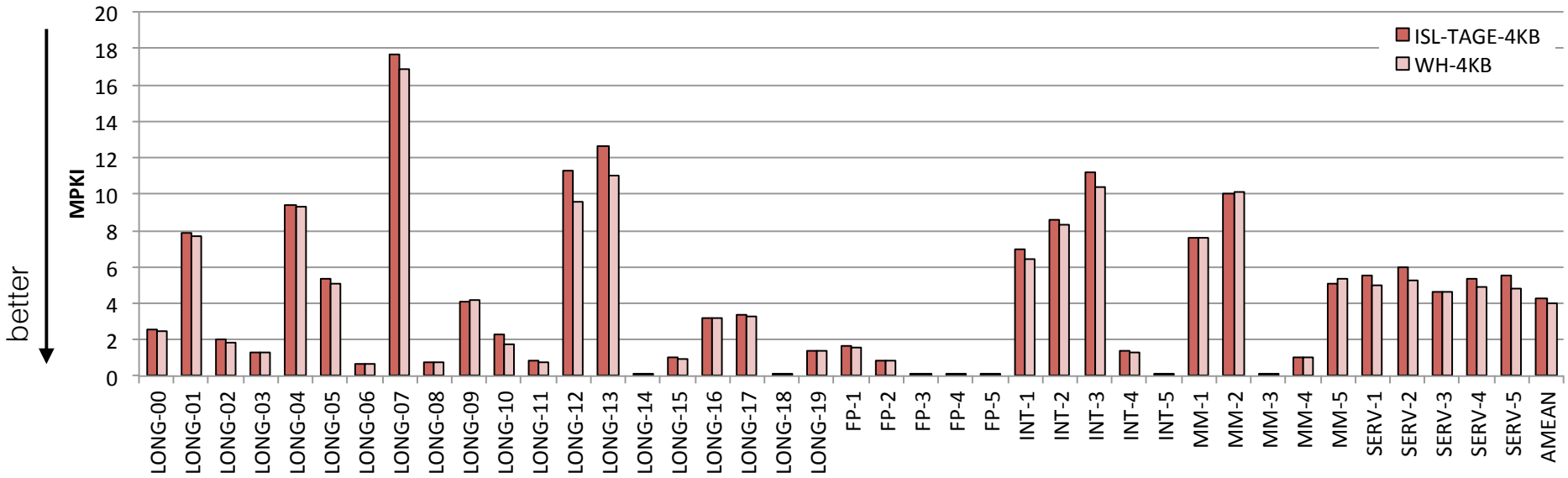
Results: 32KB



Big improvements on two traces

32KB: Avg. MPKI = 2.498

Results: 4KB


ISL-TAGE-4KB
WH-4KB
MPKI
better
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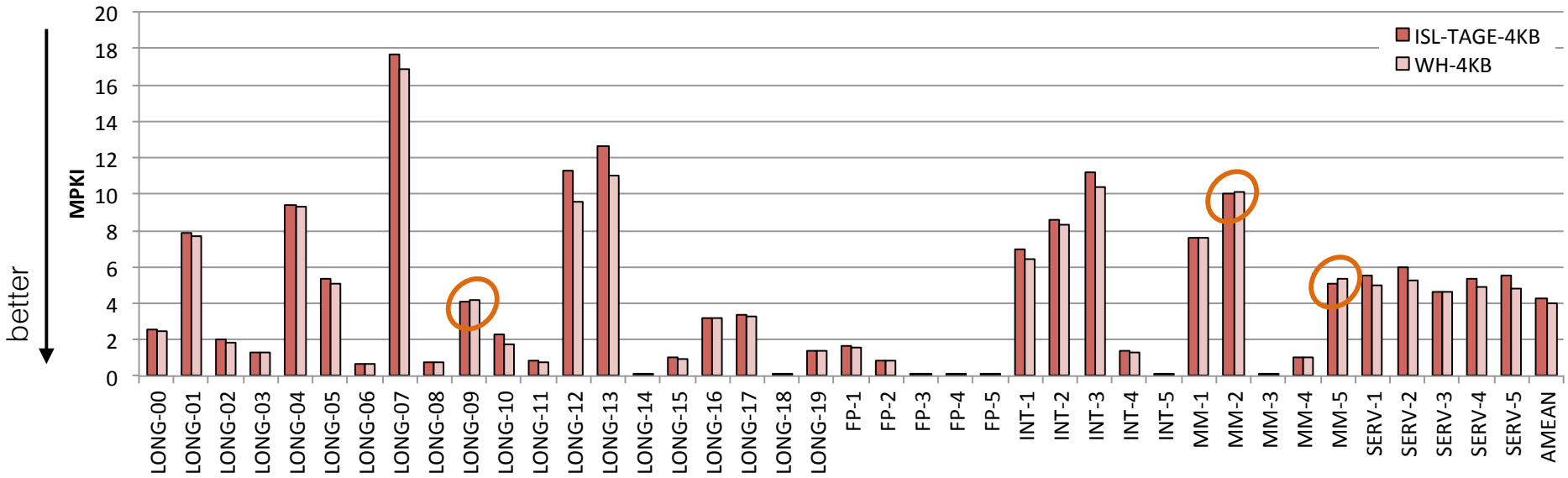
AMEAN

Results: 4KB


ISL-TAGE-4KB
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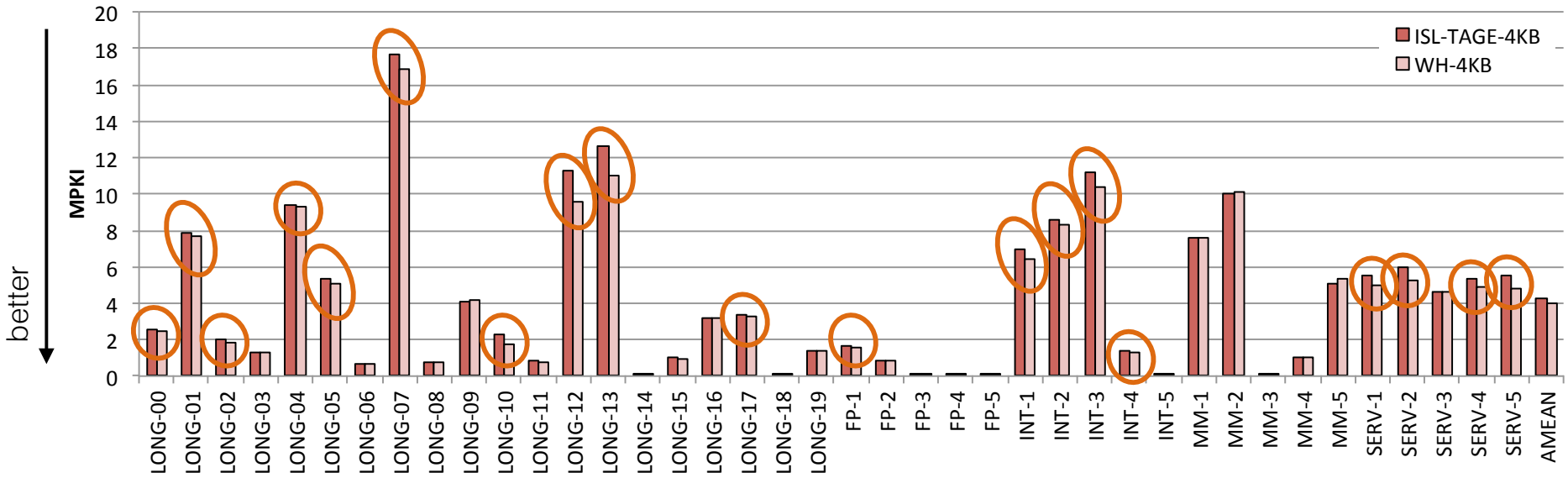
Results: 4KB


ISL-TAGE-4KB
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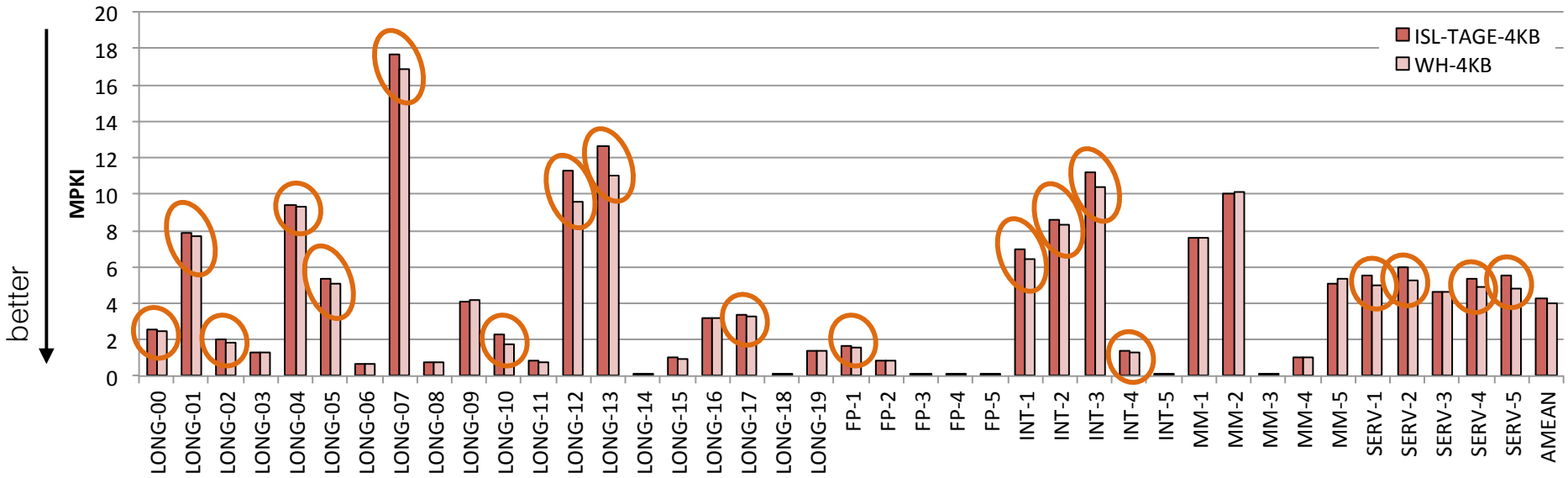
Results: 4KB



Better than ISL-TAGE in 20 out of 40 traces (4.6% on avg.)
4KB: Avg. MPKI = 3.995

Wormhole predictor's storage

	4KB	**32KB**
Statistical corrector	96	384
Loop predictor	376	376
TAGE predictor	3589	30476
Wormhole predictor	134	1413
Total size (bytes)	4195	32649

Conclusion

- **Wormhole predictor**:
  Side-predictor on top of ISL-TAGE

- Able to consider the branch history as multidimensional, capturing columns, diagonals and other patterns

- **3.995**, **2.498**, and **2.014** MPKI in the 4KB, 32KB, and unlimited competition tracks, respectively

Conclusion

- **Wormhole predictor**:
  Side-predictor on top of ISL-TAGE

- Able to consider the branch history as multidimensional, capturing columns, diagonals and other patterns

1	0	1	0	0
1	0	1	0	0
1	0	1	0	0

- **3.995**, **2.498**, and **2.014** MPKI in the 4KB, 32KB, and unlimited competition tracks, respectively

Wormhole branch prediction using multi-dimensional histories

Jorge Albericio, Joshua San Miguel,
Natalie Enright Jerger, and Andreas Moshovos

Questions?