**Base-Delta-Immediate Compression: Practical Data Compression for On-Chip Caches**

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**Motivation & Background**

Significant redundancy in data:

- **Zero Values**: initialization, sparse matrices
- **Repeated Values**: common initial values
- **Narrow Values**: small values in a big data type
- **Other Patterns**: pointers (same memory region)

Cache compression provides the effect of a larger cache without making it physically larger.

Key requirements:

- **Fast** (low decompression latency)
- **Simple** (avoid complex hardware changes)
- **Effective** (good compression ratio)

**Base-Delta-Immediate Compression**

- Use multiple bases to increase compression coverage
- **Pro**: More cache lines can be compressed
- **Cons**: 1. Unclear how to find, 2. Higher overhead
- Empirically, 2 bases is the best for our set of applications
- Idea:
  1. **First** base – first element in the cache lines (**base+Δ**)
  2. **Second** base – implicit base of 0 (**immediate**)

**BΔI Implementation**

- Decompressor design: vector addition (fast)
- Compressor design
  - arithmetic (+/-) and comparisons
- BΔI cache organization
  - 2X tags + compr. encoding
  - Data segmenting (e.g., 8-byte)

**Key Results: Performance**

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<tbody>
<tr>
<td>1</td>
<td>5.1%</td>
<td>4.1%</td>
<td>2.1%</td>
<td>1.0%</td>
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<tr>
<td>2</td>
<td>9.5%</td>
<td>5.7%</td>
<td>3.1%</td>
<td>1.2%</td>
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<tr>
<td>4</td>
<td>11.2%</td>
<td>5.6%</td>
<td>3.2%</td>
<td>1.3%</td>
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**Key Results: Compression Ratio**

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<th>2-core mixes</th>
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<th>GeoMean</th>
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<tbody>
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<td>3.4%</td>
<td>4.3%</td>
<td>10.9%</td>
<td>16.5%</td>
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