A 2bcgskew Fused by a RHSP

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A 2bcgskew...

[André Seznec, 2003]

4 component predictors:
- Bimodal
- Gshare (G0)
- Gshare (G1)
- Meta

META selects between
- Majority vote BIM/G0/G1
- BIM prediction

2bcgskew
A 2bcgskew...

Shared prediction tables:
- $2^{N-1}$ bias G0/G1
- $2^{N-2}$ bias BIM/META
- $2^{N-2}$ hysteresis bits
BIM/G0/G1/META

Indexing:
Bimodal pure addr
G0 addr + 12 global hist
G1 addr + 24 global hist
META addr + 3 global hist

2bcgskew
Fusion principle

[Gabriel Loh, 2002]

- **Hybrid**
  - selects component based on META-predictor
  - follows outcome of one component

- **Fusion**
  - learns patterns from component outcomes
  - improved accuracy if component outcomes differ
Extracts multiple bits from 2bCGSkew

9 outcome bits:
- 2bCGSkew
- BIM bias + hysteresis
- G0 bias + hysteresis
- G1 bias + hysteresis
- META bias + hysteresis

1st JILP Championship Branch Prediction (CBP-1) --- December 5, 2004
... a RHSP predictor

[André Seznec, 2003]
### Perceptron Predictor

<table>
<thead>
<tr>
<th>Information</th>
<th>#bits</th>
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</thead>
<tbody>
<tr>
<td>Global History</td>
<td>33</td>
</tr>
<tr>
<td>Local History</td>
<td>6</td>
</tr>
<tr>
<td>Pseudo-tag</td>
<td>8</td>
</tr>
<tr>
<td>Outcomes</td>
<td>9</td>
</tr>
<tr>
<td>Bias</td>
<td>1</td>
</tr>
</tbody>
</table>

- **Local history table**
  - 512 entries
  - Indexed by branch address

- **Pseudo-tag bits**
  - [André Seznec, 2003]
  - Higher order address bits not used to select weights
### Redundant History Perceptron Predictor

<table>
<thead>
<tr>
<th>Information</th>
<th>Redundancy</th>
<th>#bits</th>
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</thead>
<tbody>
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\[ \text{n-th order redundancy of } h: \]

\[
\begin{array}{c}
\oplus^n \\
\hline
h_5 & h_4 & h_3 & h_2 & h_1 & h_0 \\
\hline
x_4 & x_3 & x_2 & x_1 & x_0
\end{array}
\]
## Redundant History

### Skewed Perceptron Predictor

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<th>Bank 3</th>
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1st JILP Championship Branch Prediction (CBP-1) --- December 5, 2004
Redundant History Skewed Perceptron Predictor

- 4 banks
- 32 entries = 5 bits index
- indexed by global history and rotation hashing function of branch address
- 8-bit weights
- MAC: (A+B, A-B) coding
- together 116 weights/entry
2bcgskew
32K bits

GBHR
ADDRESS

Fusion
RHSP
predictor
29K bits

Local
history
3K bits

prediction
Performance???
The end