Motivation

Static locality analysis:
+ Do not need to run program
+ Detailed feedback related to code structure
- Difficult to handle cache line granularity

Recent research shows how to use reuse time distribution to calculate miss ratio and write back ratio. (HOTL[1], AET[2], Write locality[3])

Reuse time (rt) is the number of memory accesses between use and its reuse.

Relation:
For use at reference ri and reuse at reference rj:
\[ rt = \vert v \vert \times R + O_r - O_i \]

R is the occurrence order of a reference in the loop.

Shortest dependence distance

Assumption: a loop nest whose dependence distances for all pairs of memory references to each array are all vectors of constants.

Among all the dependences from a single source src, the shortest distance v(src) is contributed by its reuse.

\[ v(src) = \min \{ v(src, snk) \mid snk \in ref \} \]

Our goal: precise cache line miss ratio curves

5-point stencil:
for (int i = 1; i < 1025; i++)
for (int j = 1; j < 1025; j++)
b[i][j] = a[i][j] + a[i][j+1] + a[i][j-1] + a[i-1][j] + a[i+1][j];

Example for shortest dependence distance (element granularity)

1. Dependence distance for source a[i][j]

<table>
<thead>
<tr>
<th>src\snk</th>
<th>a[i][j]</th>
<th>a[i][j+1]</th>
<th>a[i][j-1]</th>
<th>a[i+1][j]</th>
<th>a[i-1][j]</th>
</tr>
</thead>
<tbody>
<tr>
<td>v(src)</td>
<td>(0, 1)</td>
<td>(1, 0)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Valid iteration range

| Range for i | (1, 1024) | (1, 1023) |
| Range for j | (1, 1023) | (1024, 1024) |

3. Shortest dependence distance

<table>
<thead>
<tr>
<th>src</th>
<th>a[i][j]</th>
</tr>
</thead>
<tbody>
<tr>
<td>v(src)</td>
<td>(0, 1)</td>
</tr>
</tbody>
</table>

Range for i | (1, 1024) | (1024, 1024)

Range for j | (1, 1023) | (1, 1023)

4. Reuse time histogram

<table>
<thead>
<tr>
<th>rt</th>
<th>count</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>1047552</td>
</tr>
<tr>
<td>1023</td>
<td>6147</td>
</tr>
</tbody>
</table>

Preliminary result

The test is done for 5-point stencil program with different input data sizes.

Reference