Least recently used replacement

1, 3, 2, 1, 2, 4, 4, 3, 2 which block is the least recently used??

1, 2, 2, 1, 2, 1 which block is the least recently used??

1, 2, 3, 1, 2, 3, 1, 2, 3, … assuming a set size of 2, which of LRU or random replacement results in a better hit rate?

Example (2-way set associative, Block size = 1)

\[
\begin{array}{cccc}
\text{v} & \text{tag} & \text{data} & \text{v} & \text{tag} & \text{data} \\
00 & 1 & 001 & \text{A, B, C, D} & 0 & \\
01 & 1 & 101 & \text{X, Y, Z, W} & 0 & \\
10 & 0 & & & & \\
11 & 0 & & & & \\
\end{array}
\]

101 01 001 00 (decimal address)

21 4 (decimal address)
Example (2-way set associative, Block size = 1)

<table>
<thead>
<tr>
<th>v</th>
<th>tag</th>
<th>data</th>
</tr>
</thead>
<tbody>
<tr>
<td>00</td>
<td>001</td>
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</tr>
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<td>101</td>
<td>X Y Z W</td>
</tr>
<tr>
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25 21 4 (decimal address)
Are larger blocks always better than smaller blocks?

Block size = 1

Example 1:
Decimal addresses: 0, 1, 2, 3, 4, 5, 6, 7
(larger block size is better)

Block size = 2

Example 2:
Decimal addresses: 0, 5, 0, 5, 0, 5, 0, 5
(smaller block size is better)

Is larger associativity better than larger block size?

Example 1:
Decimal addresses: 0, 1, 8, 9, 0, 1, 8, 9

2-way associative

Block size = 2

Larger associativity is better
Is larger associativity better than larger block size?

2-way associative

Example 2:
Decimal addresses: 0, 1, 2, 3, 4, 5, 6, 7

Block size = 2

Larger block size is better