Text Factorization of gzip

LZ77 with Sliding Windows

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```
0123456789012345678 90
abaabbaabaaaabbaabbbab
```

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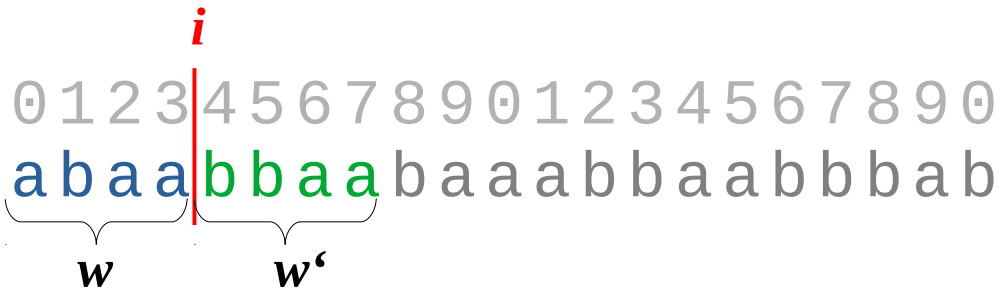
LZ77 with Sliding Windows



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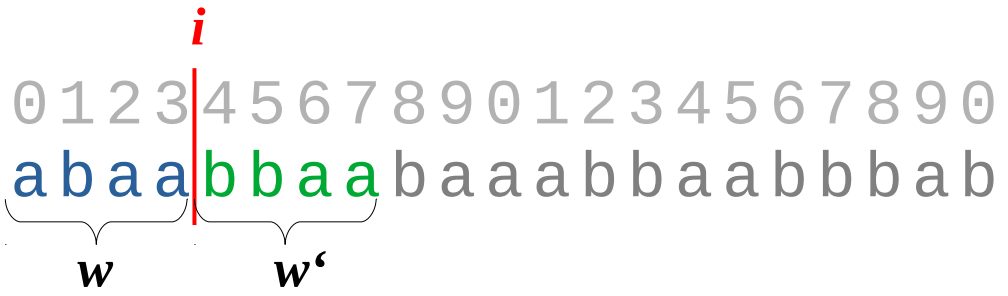

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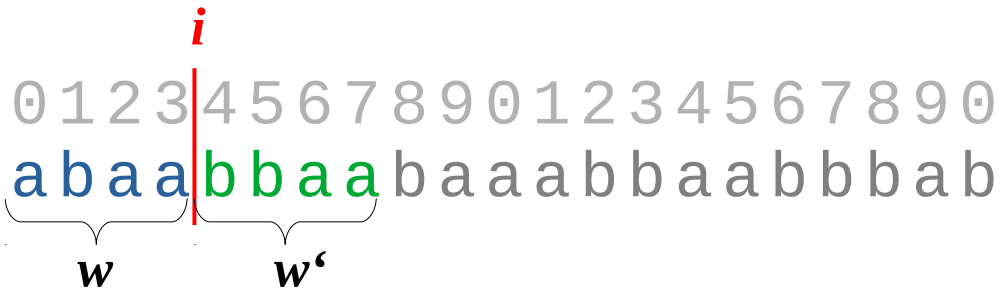

- **Goal**: Keep memory use small (order of window size)
- Window of size w
  - Already factorized
- Lookahead window of size $w‘$
  - Factorize using **pattern matching** in entire window of size $w+w‘$

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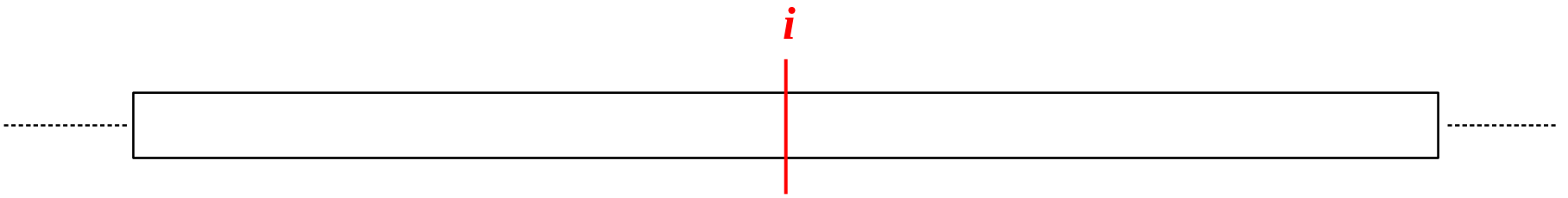
  - Ensures compatibility to 16-bit architectures
- Compression level (0 to 9)
  - Determine ***heuristic*** parameters, details follow

Pattern Matching Scheme



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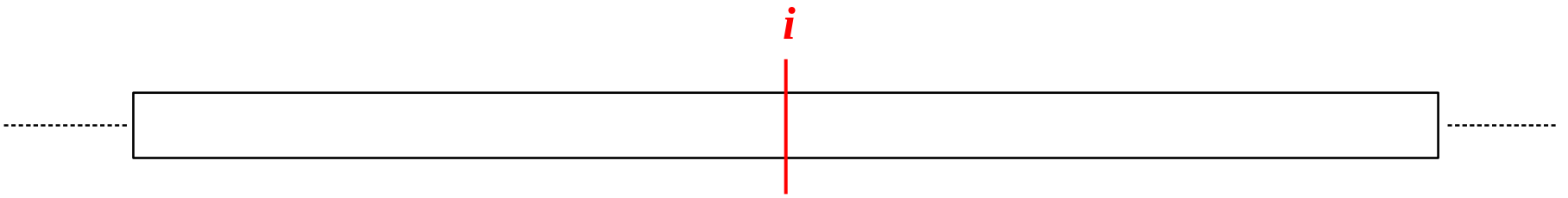

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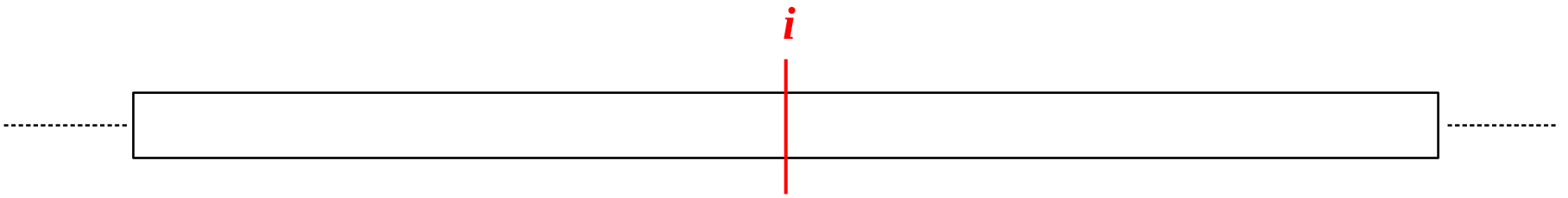

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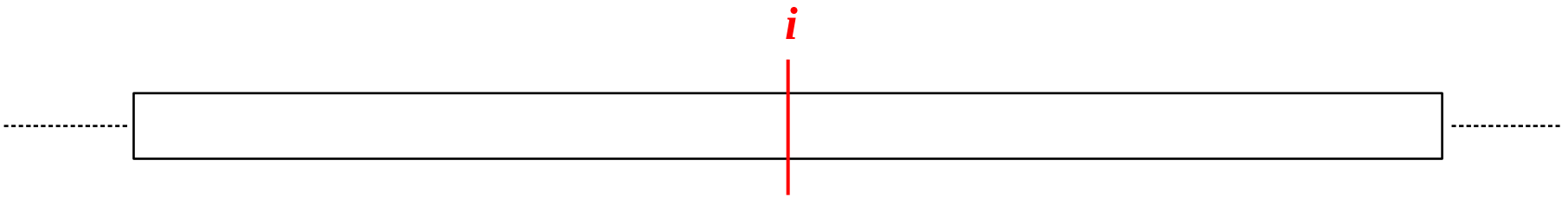

- At current position i, find set of candidate positions $i \geq j \geq i - w$
  - We only ever match against these candidates
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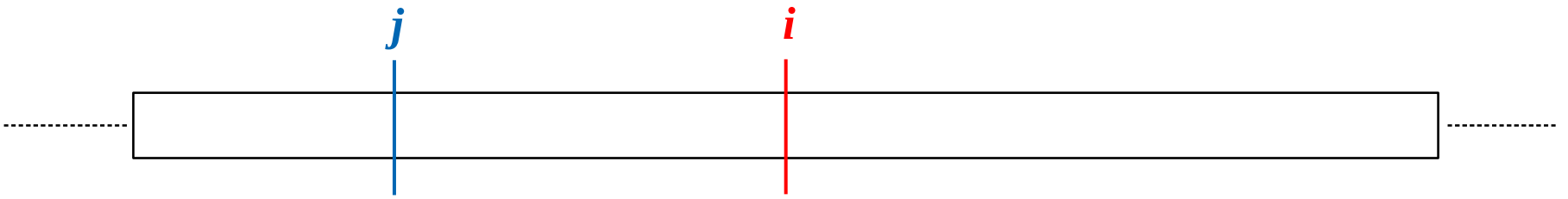
- Keep track of longest match of length L among the candidates

Pattern Matching Instance



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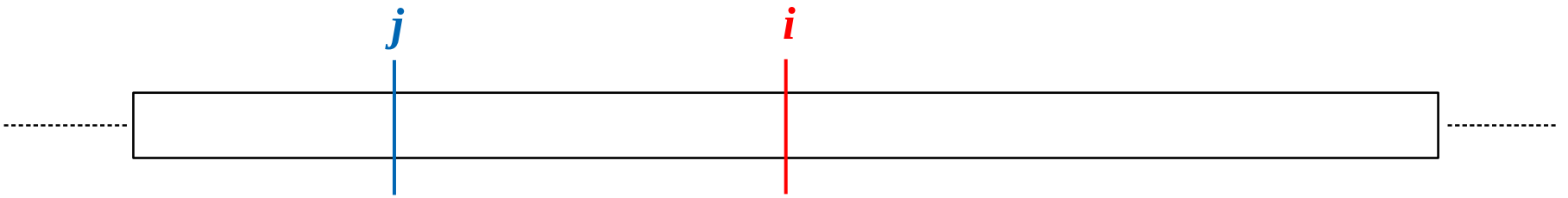

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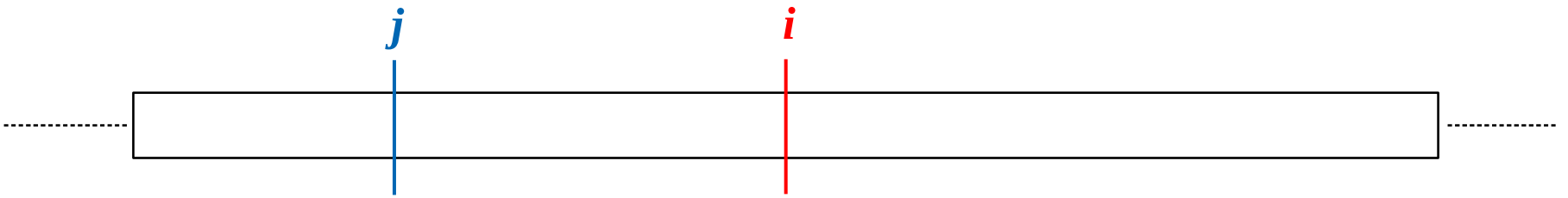

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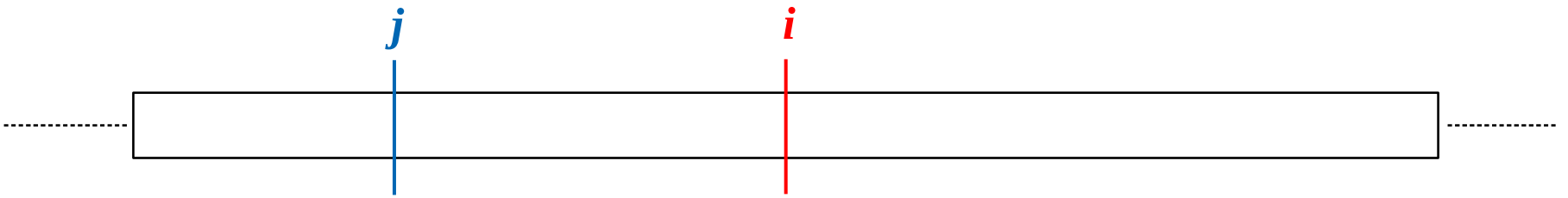

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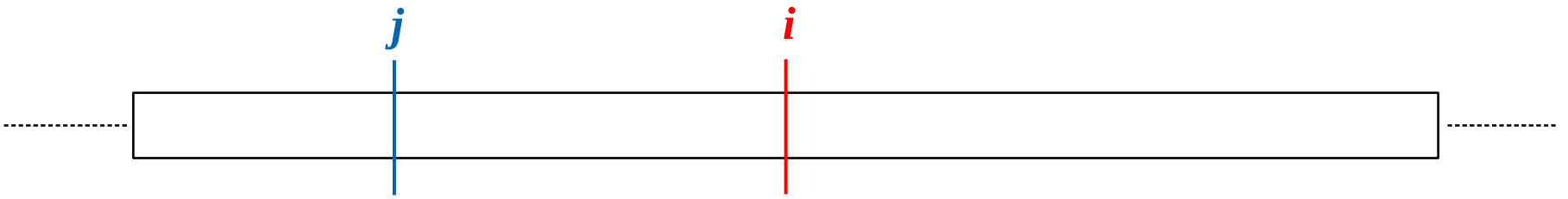

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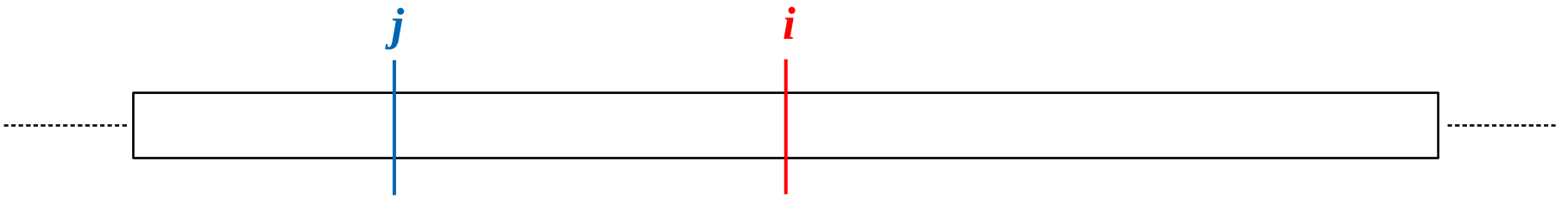

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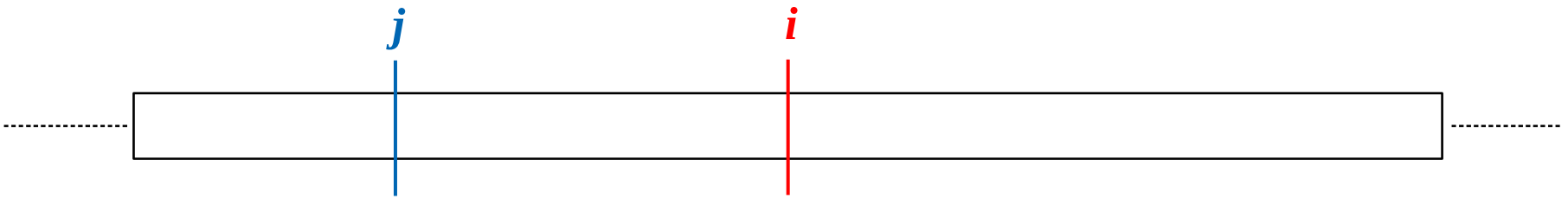

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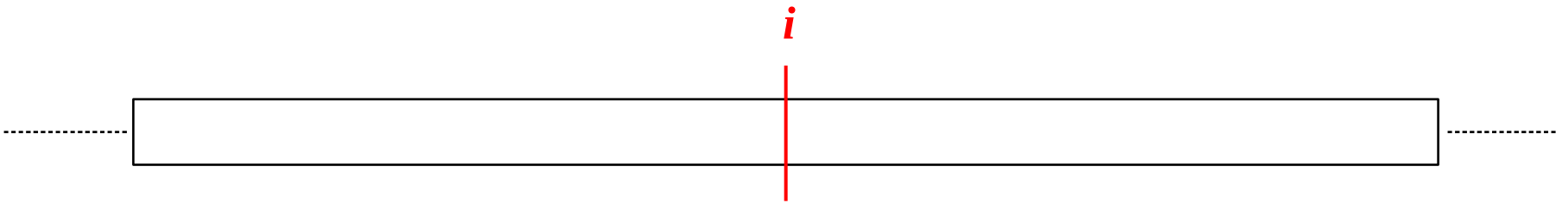
- If ℓ is a ***nice*** match, immediately emit (j, ℓ), and skip any further candidates
- Otherwise, let $L := \max\{L, \ell\}$ and go on to next candidate

Candidate Management



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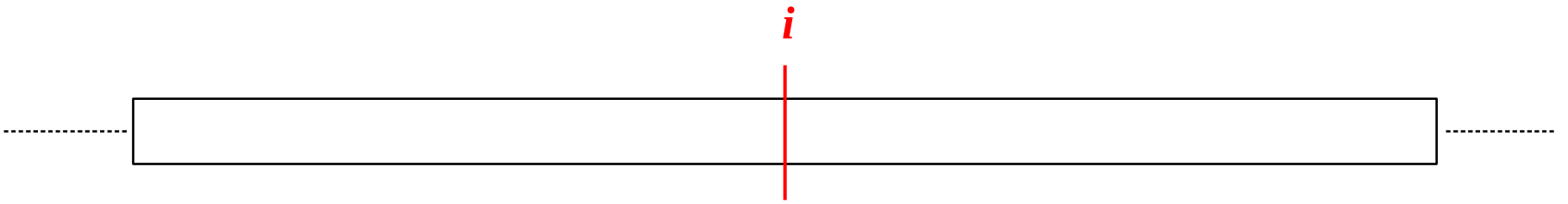

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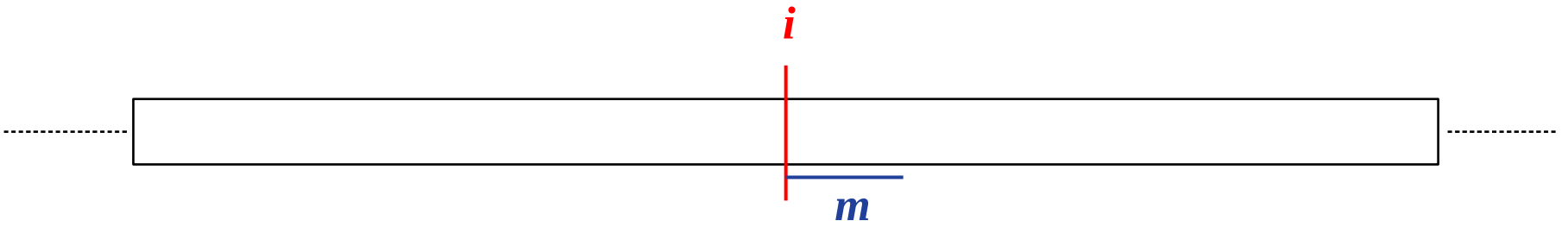

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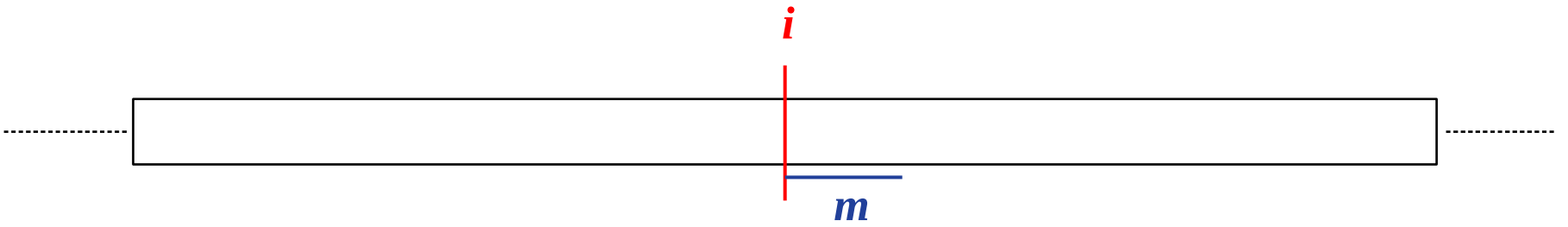

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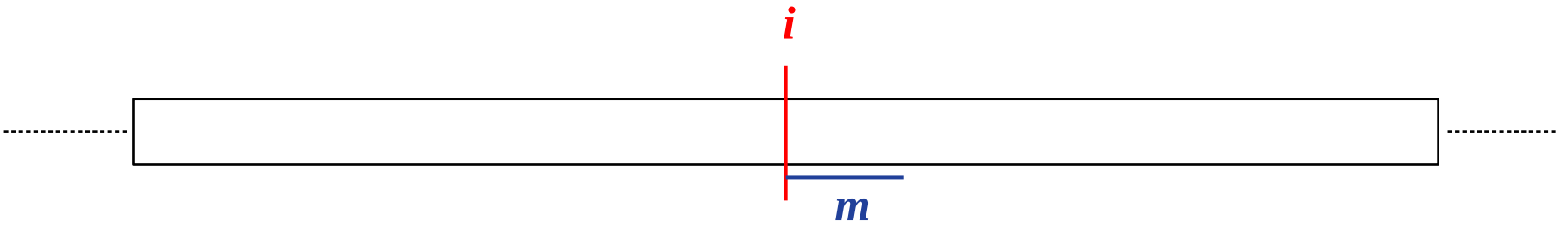

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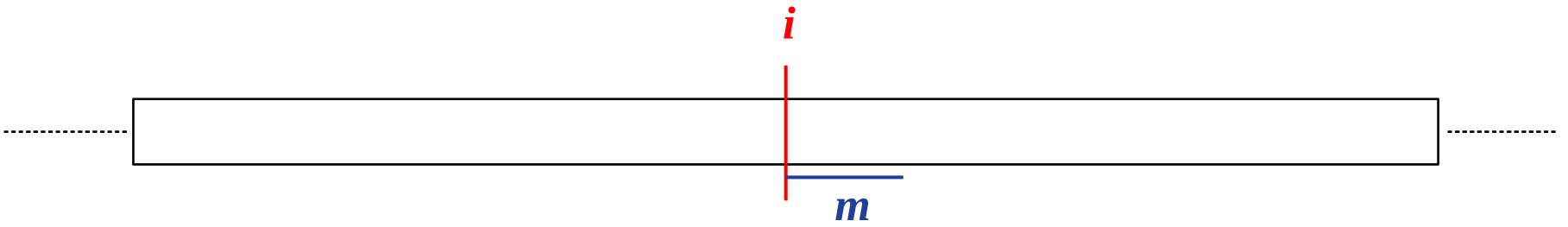

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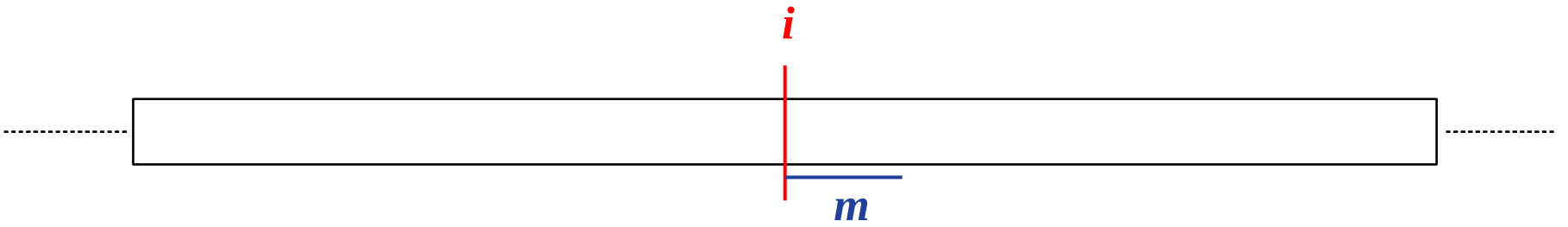

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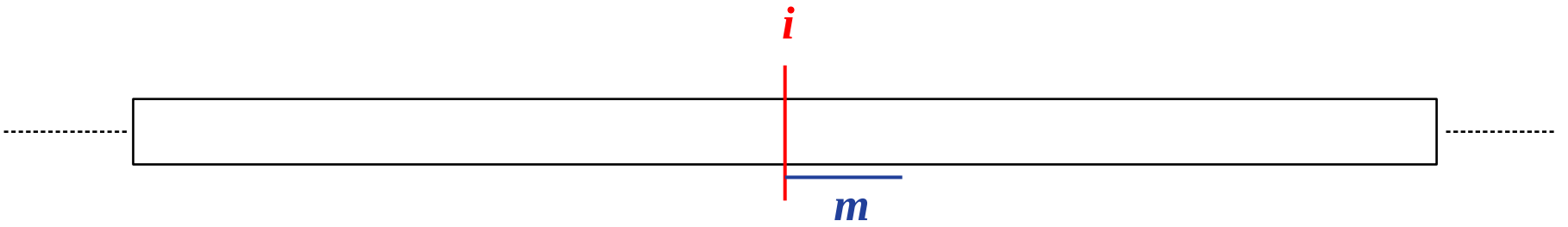

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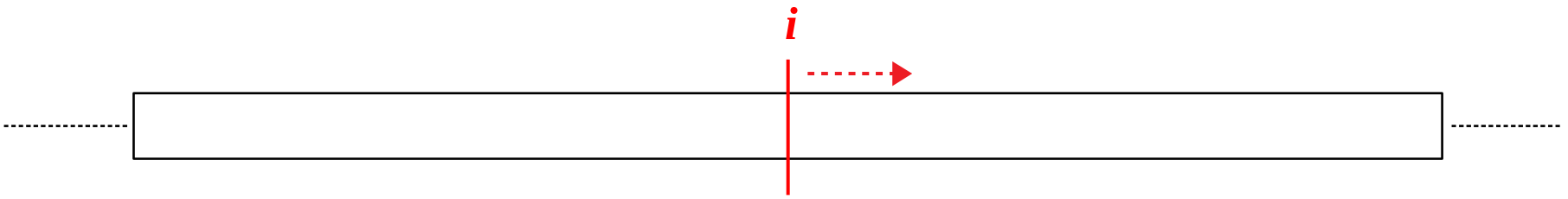
    - For any i, we follow the chain at most c times (for `gzip -9`, $c := 4096$)

Pattern Matching Aftermath



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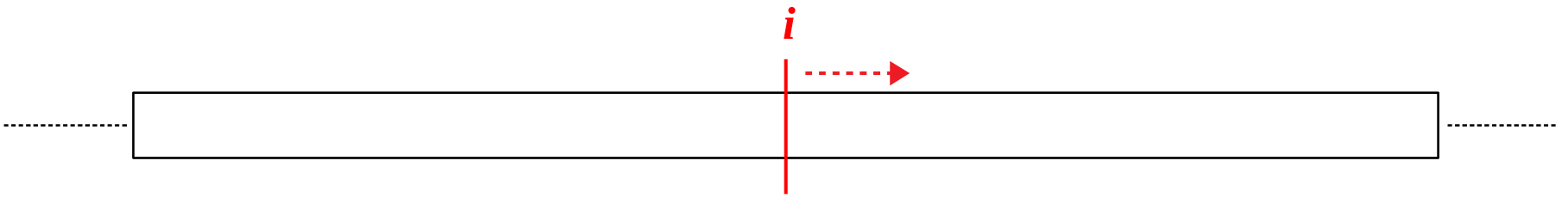

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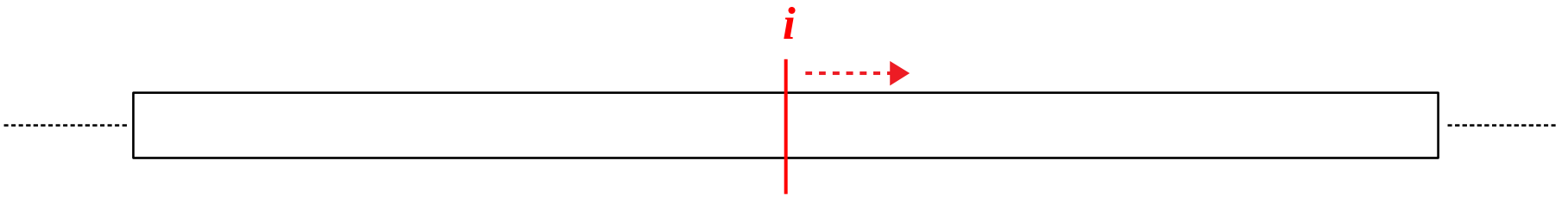

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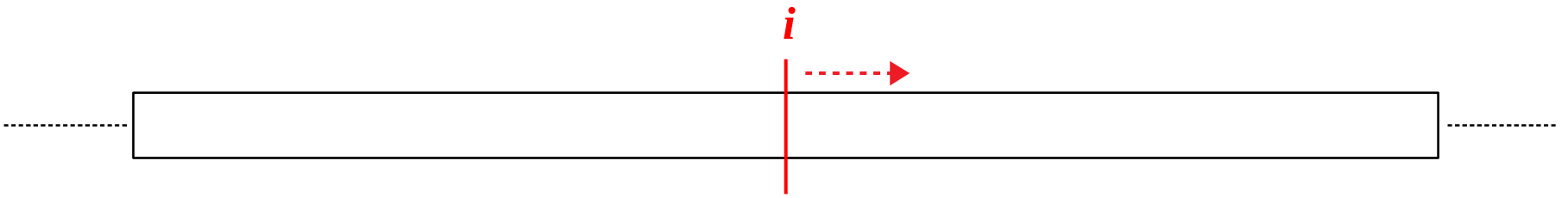

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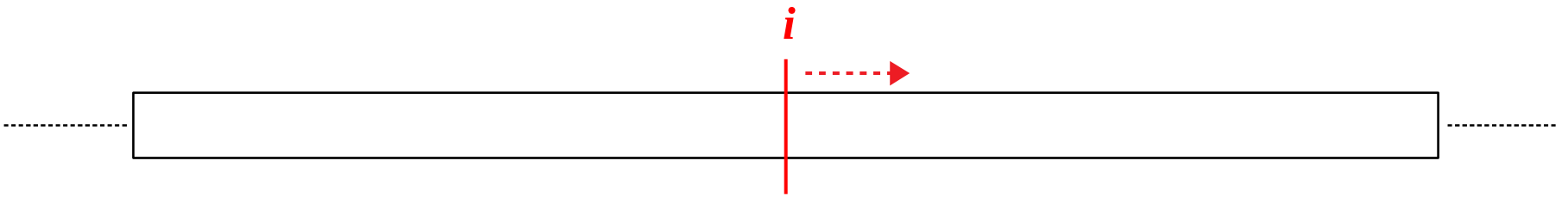

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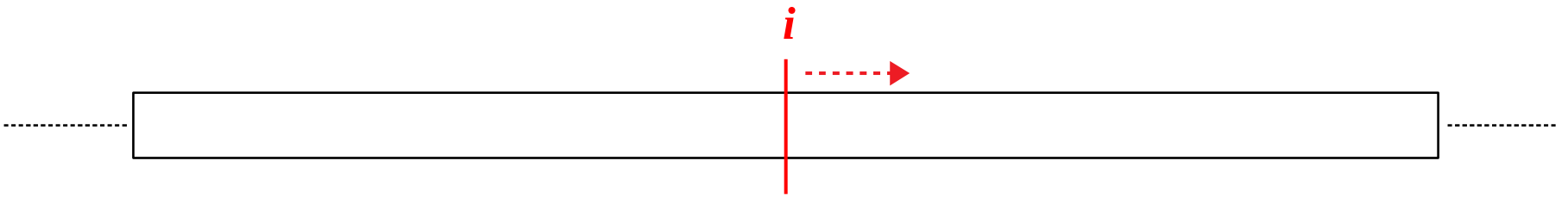

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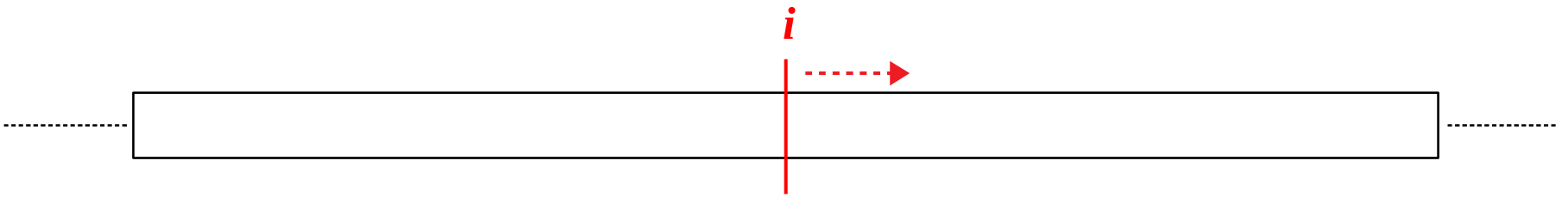

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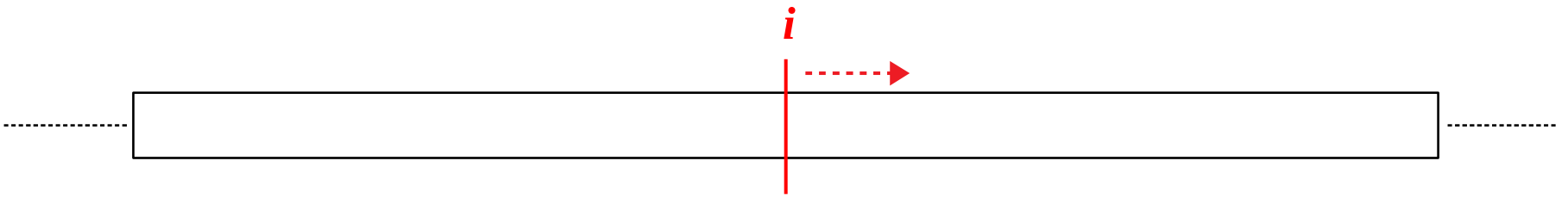

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- Set ***L'*** := ***L*** for the next step

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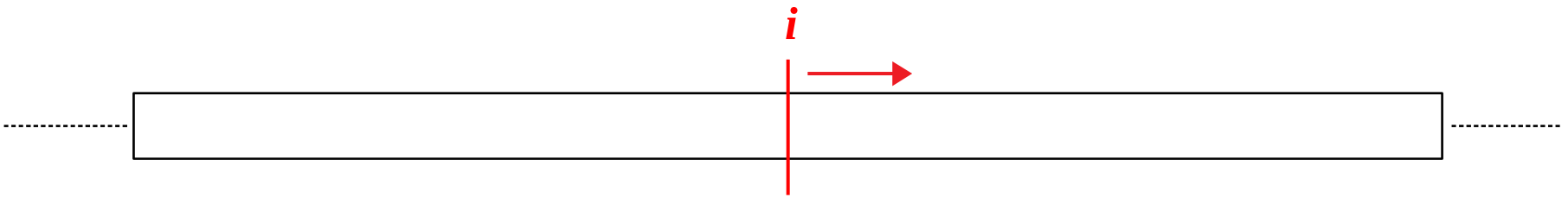

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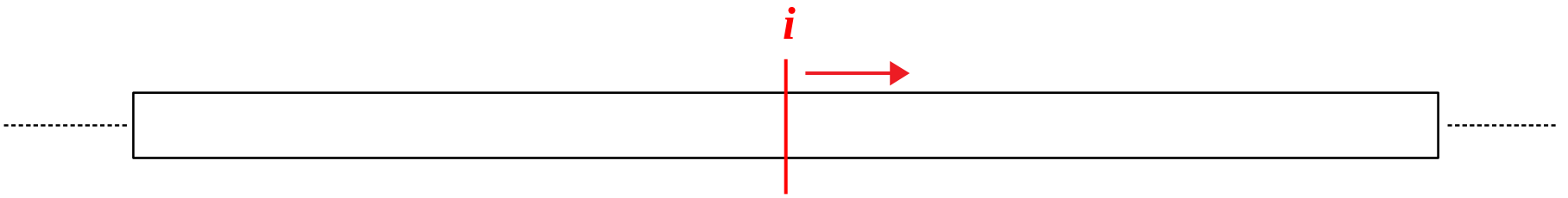

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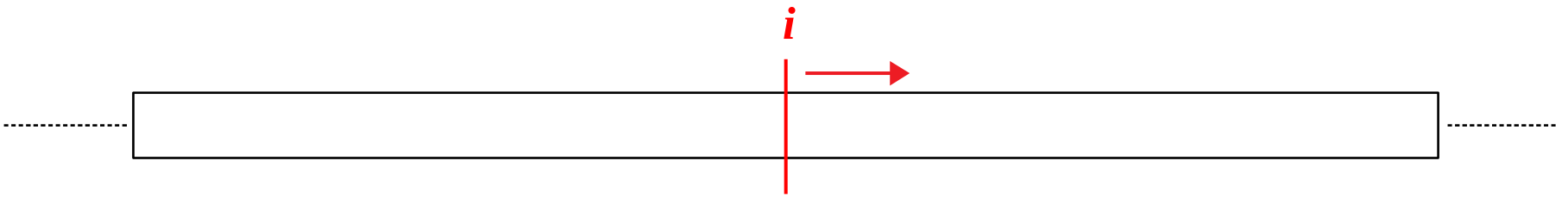

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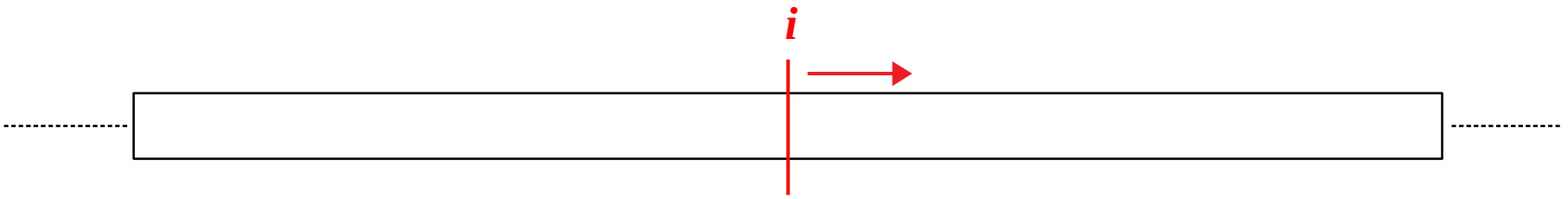

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- Otherwise, if ***L‘*** is a ***good*** match, reduce chain follow limit to $c/4$ for this step

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  - **Lazy** acceptance of references exceeding a certain length
- Level 0 indicates no compression at all (simply store input files)
- Levels 1-3 switch to a faster variant that redefines laziness
  - Enter i into hash chain only if longest match L exceeds ***lazy*** threshold

Compression Level

```
246  local config configuration_table[10] = {
247  /*      good lazy nice chain */
248  /* 0 */ {0,    0,  0,    0},  /* store only */
249  /* 1 */ {4,    4,  8,    4},  /* maximum speed, no lazy matches */
250  /* 2 */ {4,    5, 16,    8},
251  /* 3 */ {4,    6, 32,   32},
252
253  /* 4 */ {4,    4, 16,   16},  /* lazy matches */
254  /* 5 */ {8,   16, 32,   32},
255  /* 6 */ {8,   16, 128, 128},
256  /* 7 */ {8,   32, 128, 256},
257  /* 8 */ {32, 128, 258, 1024},
258  /* 9 */ {32, 258, 258, 4096}}; /* maximum compression */
```

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