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2.3 PARTITIONING DEMOS

- *Hoare 2-way partitioning*
- *Dijkstra 3-way partitioning*
- *Bentley–McIlroy 3-way partitioning*
- *dual-pivot partitioning*

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Repeat until `i` and `j` pointers cross.

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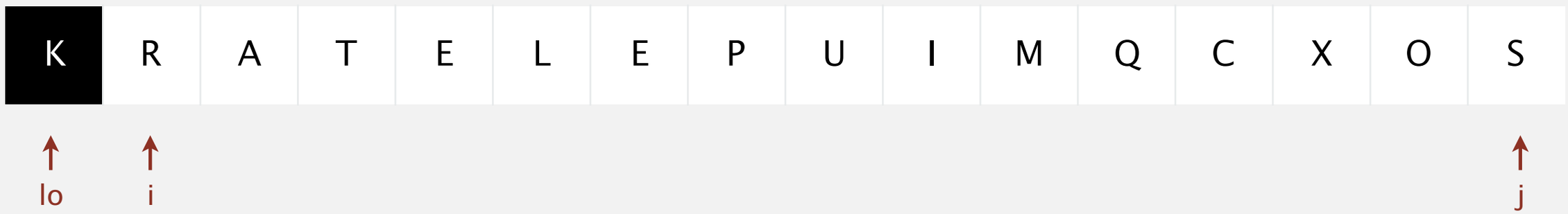

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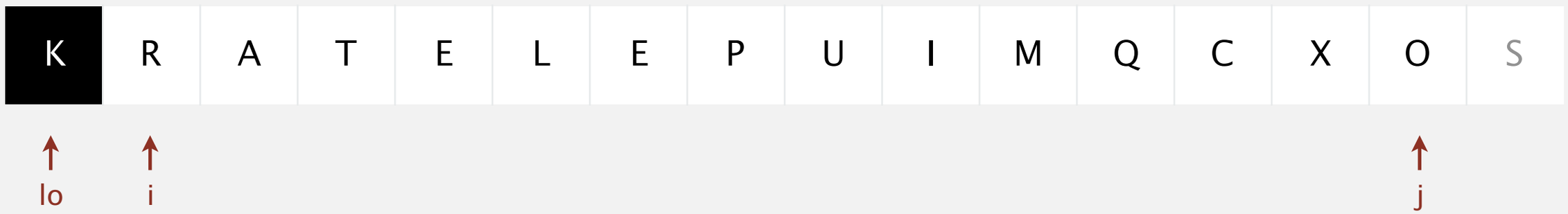

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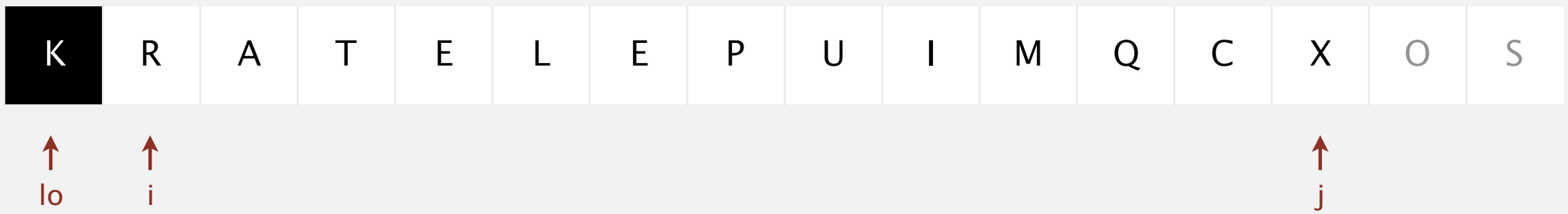

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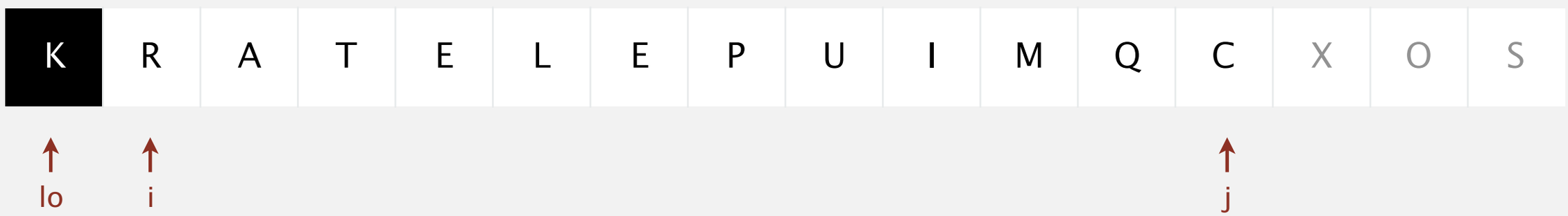

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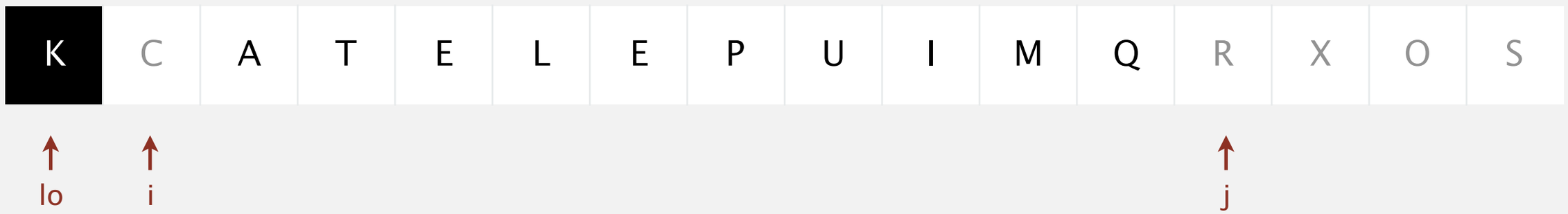

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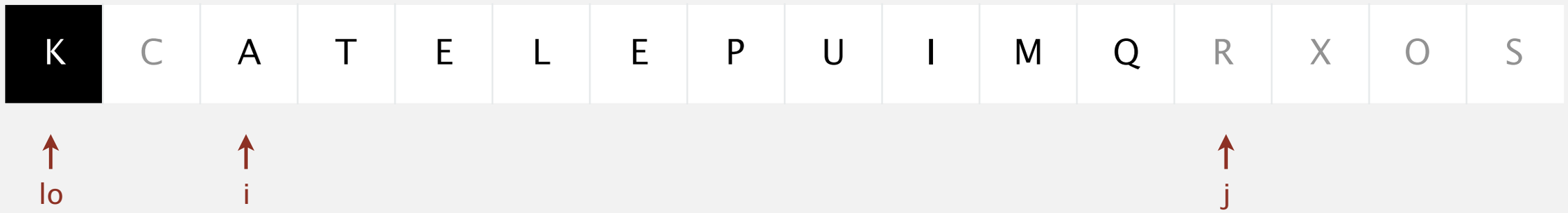

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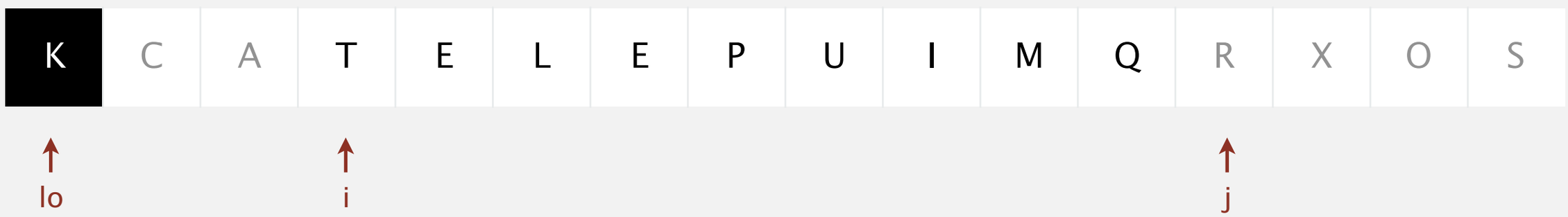

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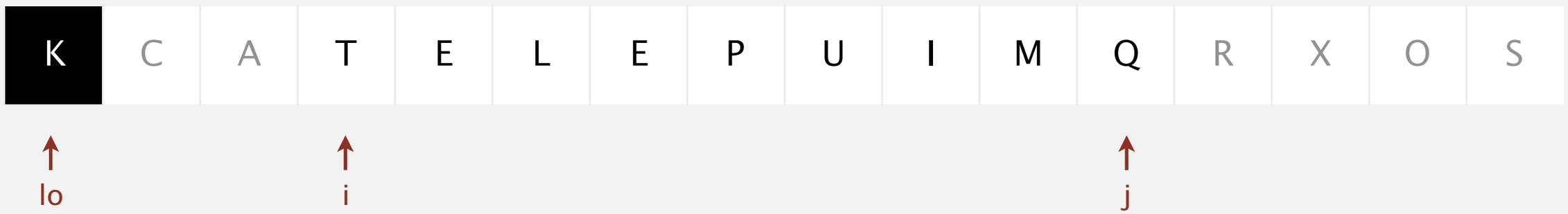

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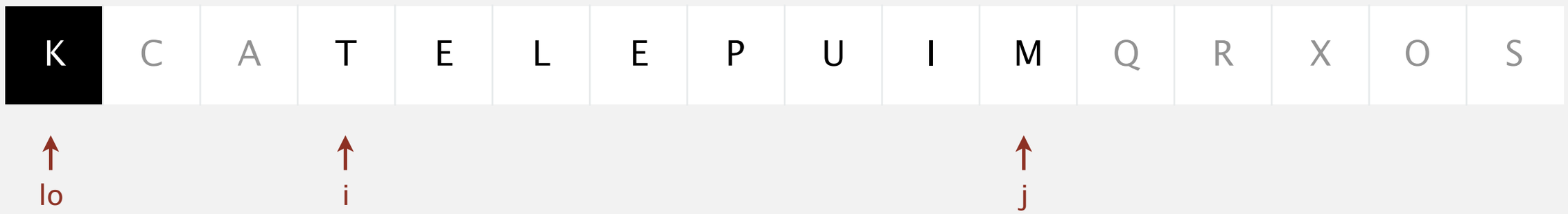

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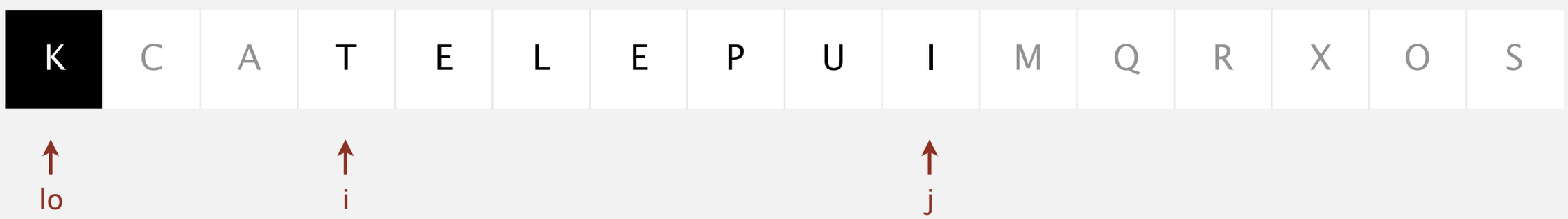

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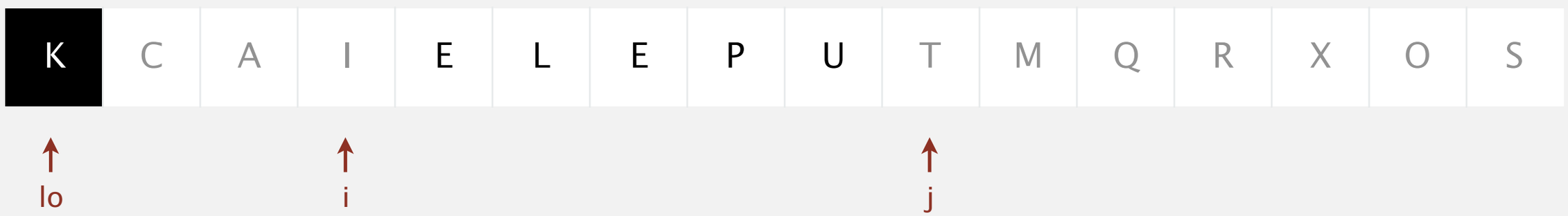

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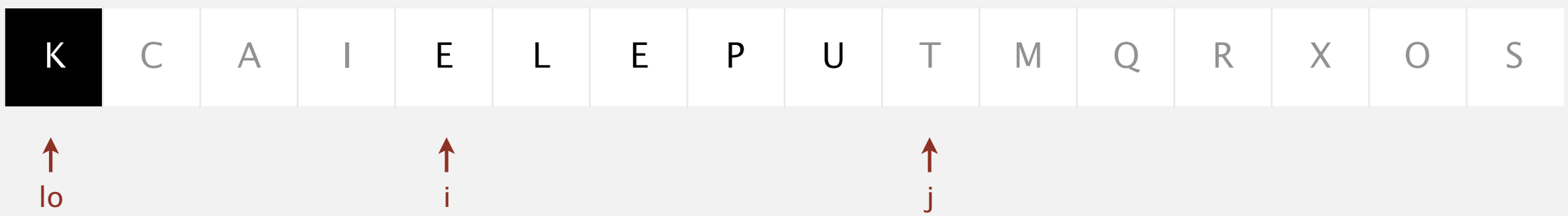

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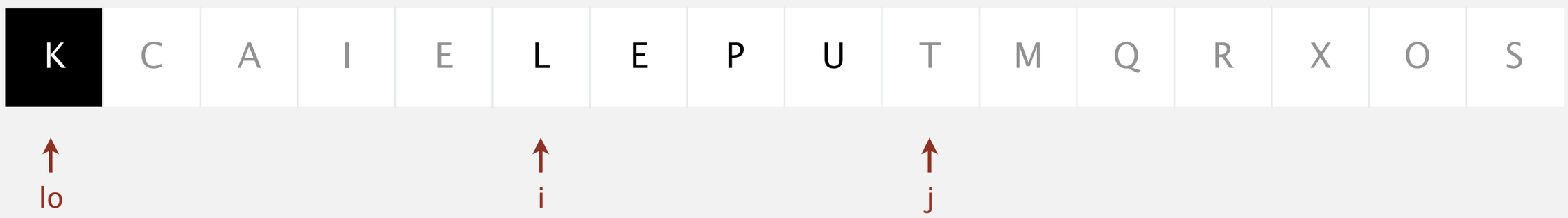

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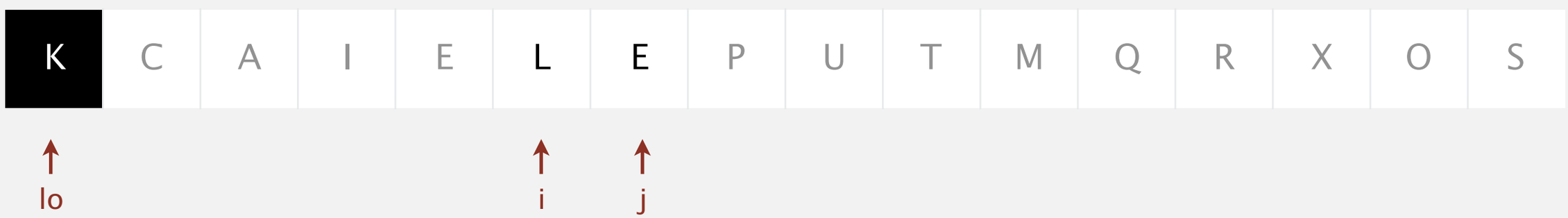

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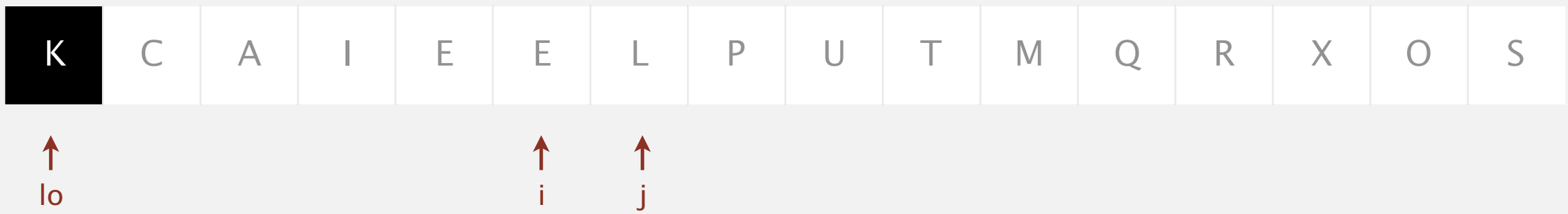

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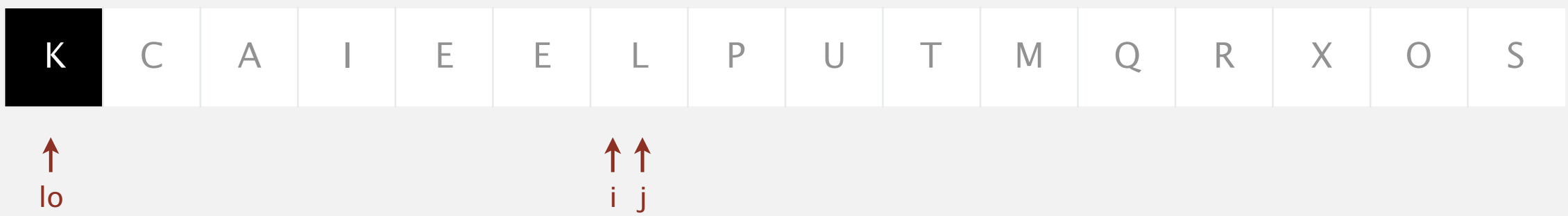

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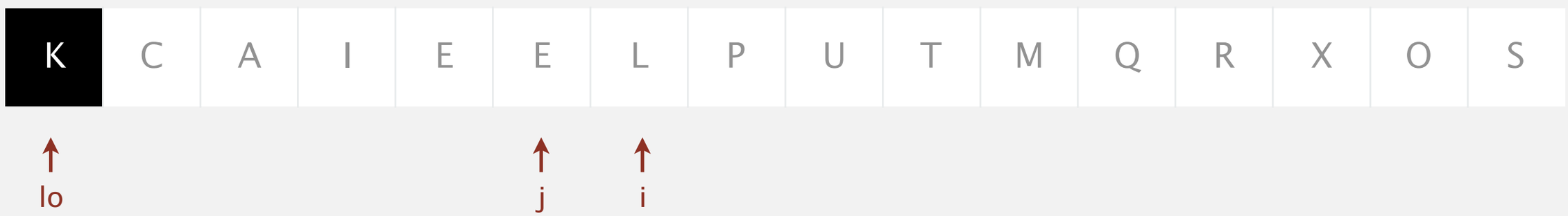

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When pointers cross.

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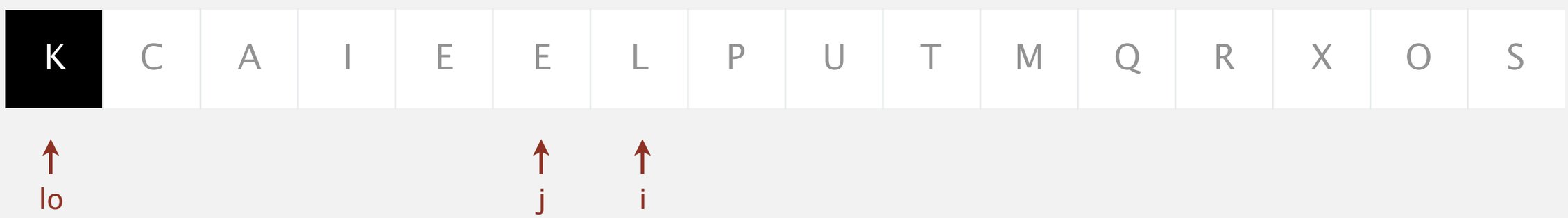

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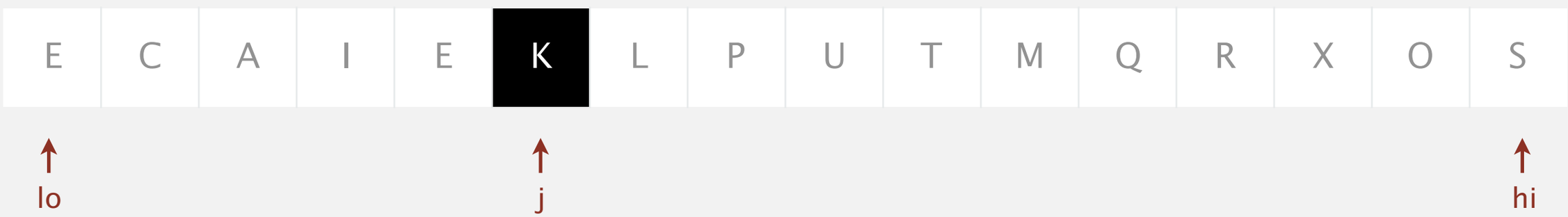

partitioned!

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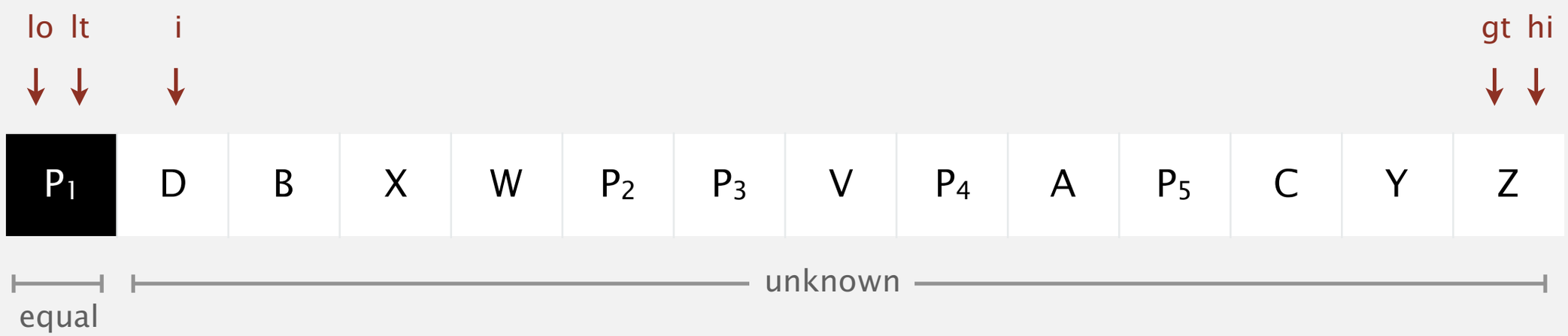

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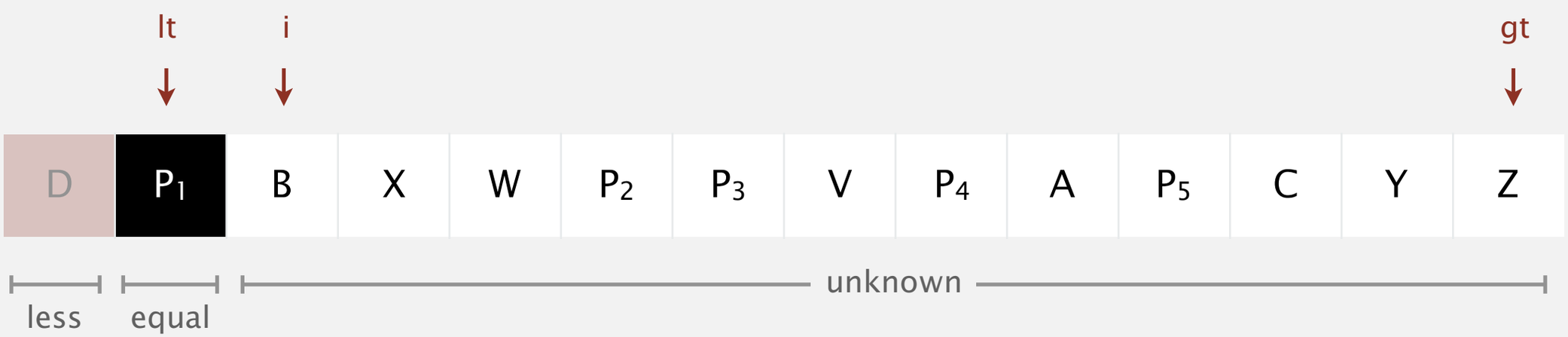

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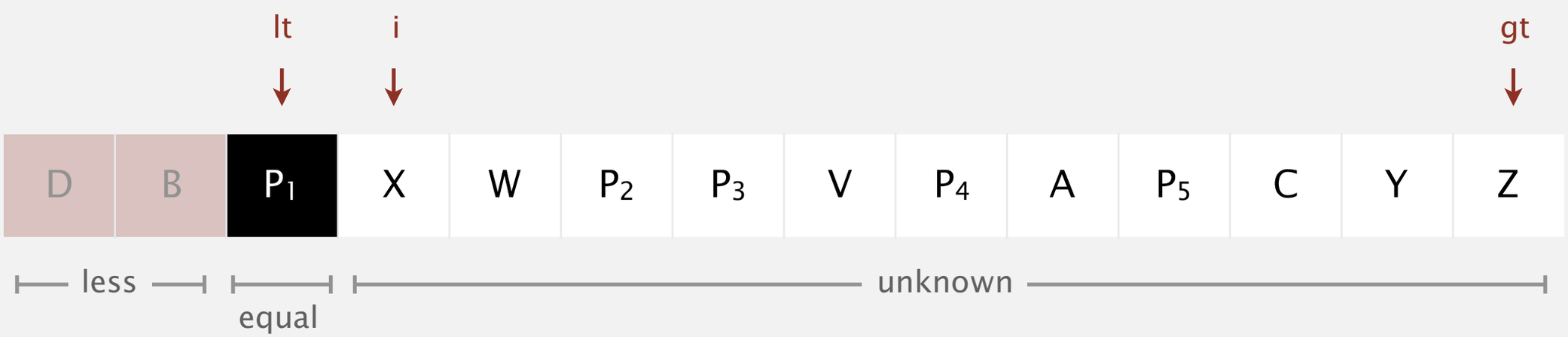

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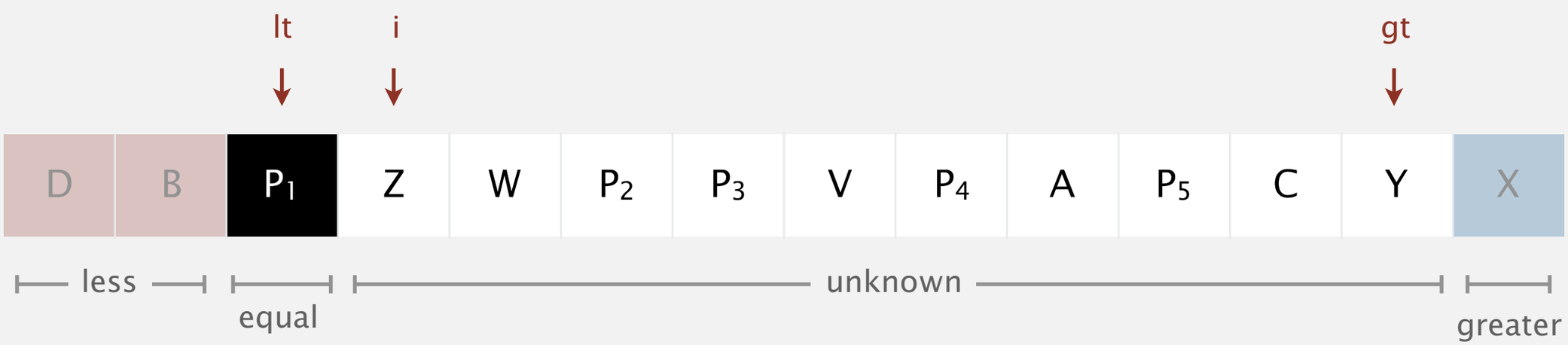

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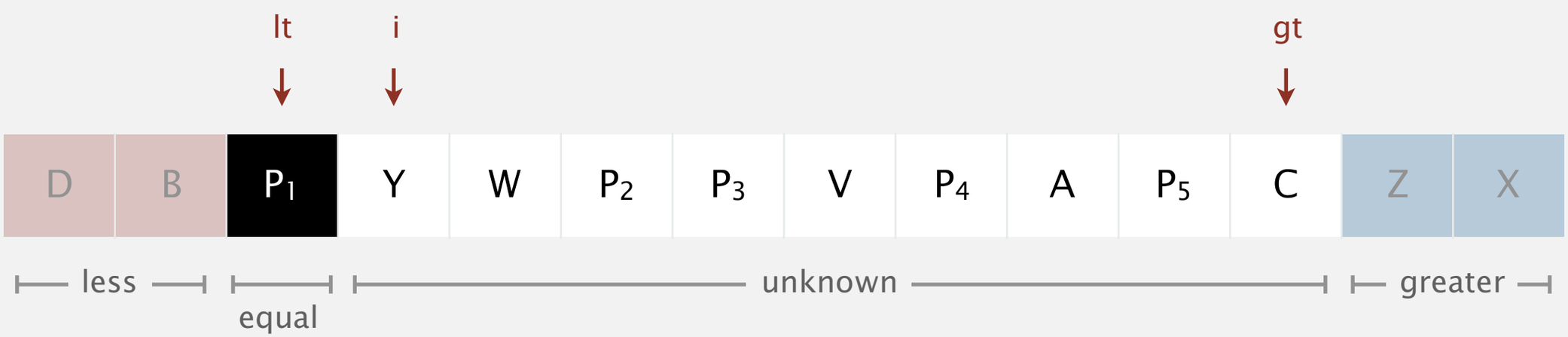

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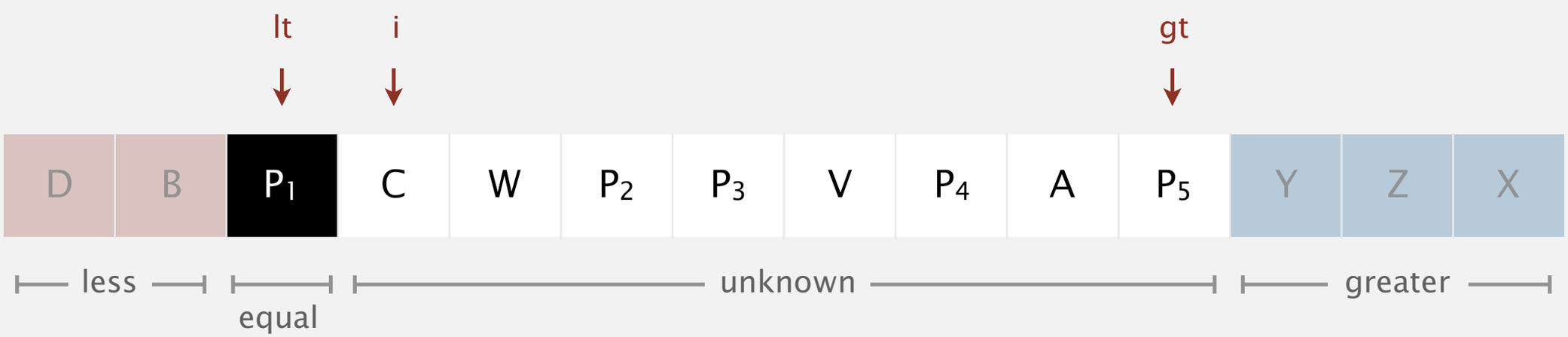

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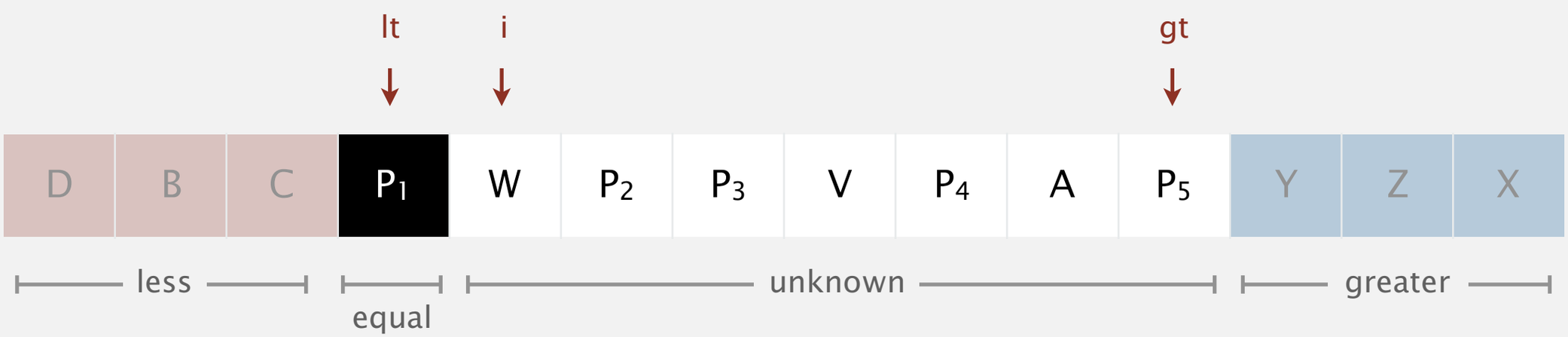

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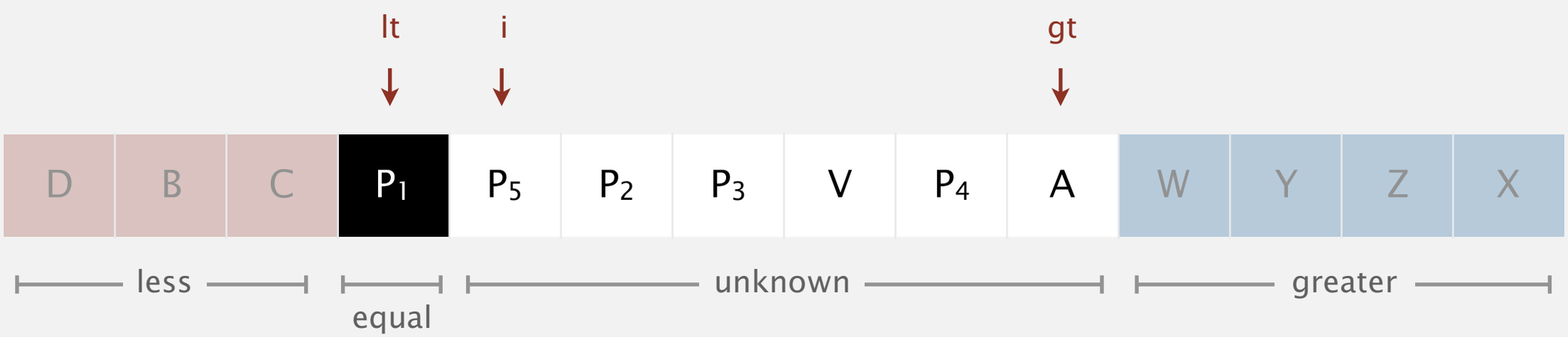

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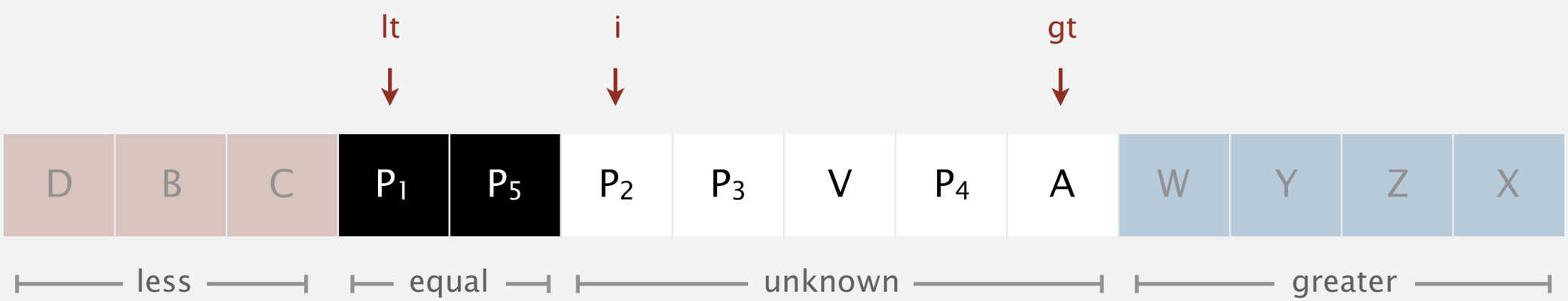

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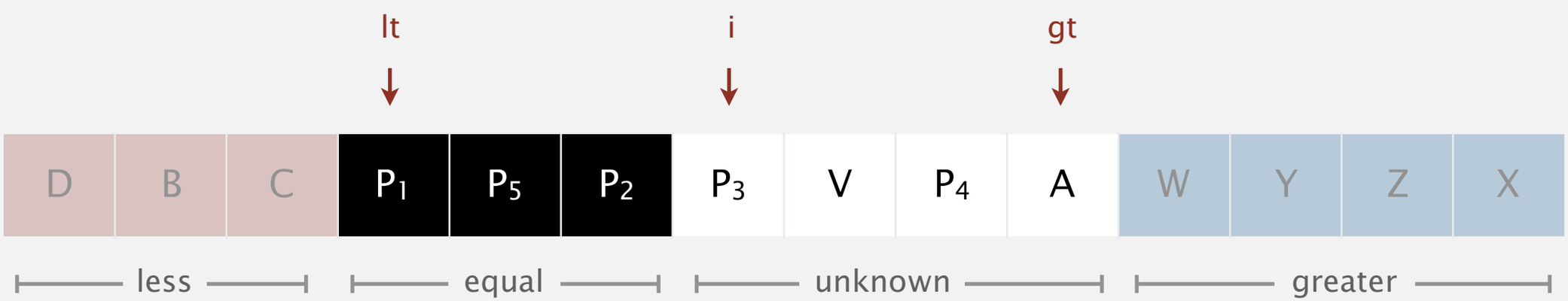

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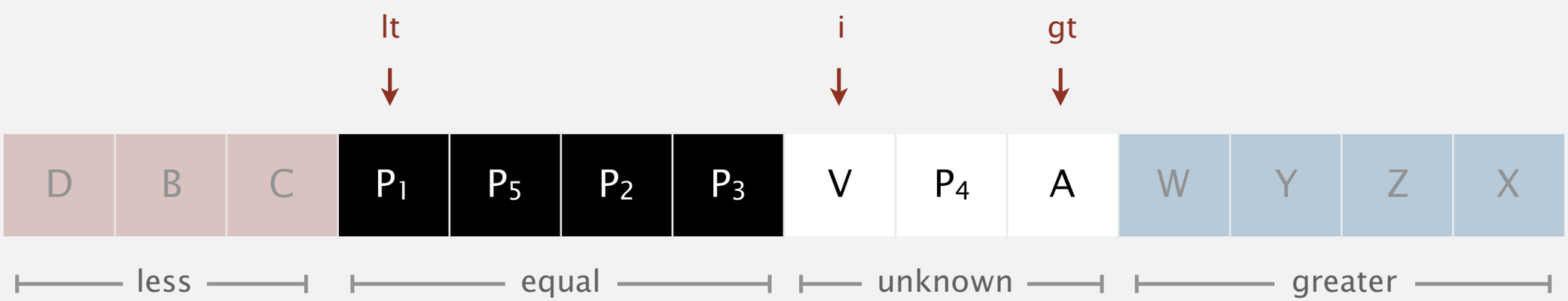

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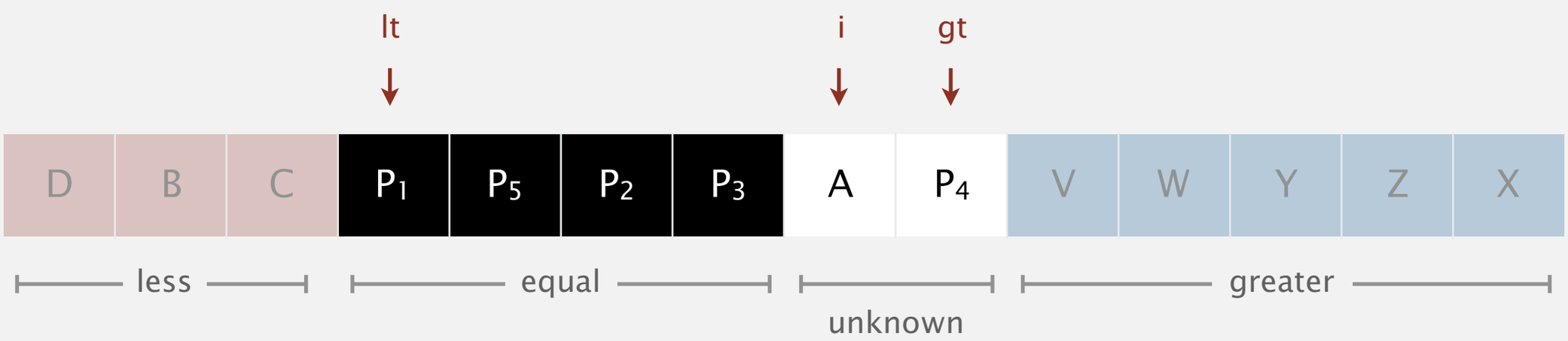

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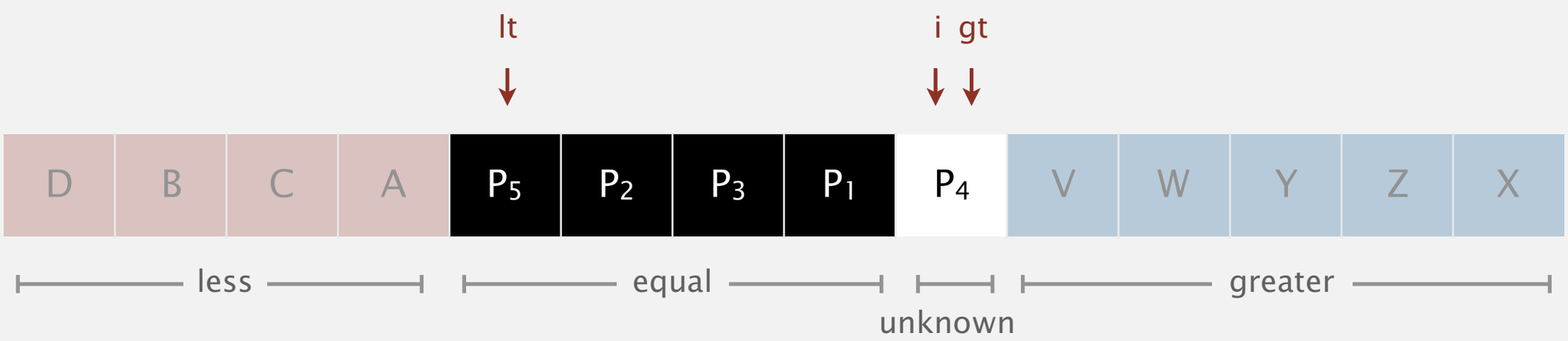

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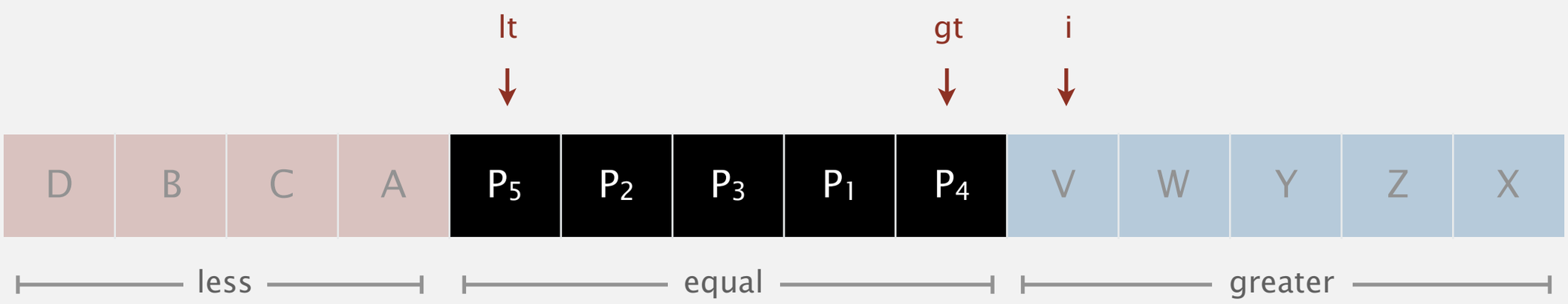
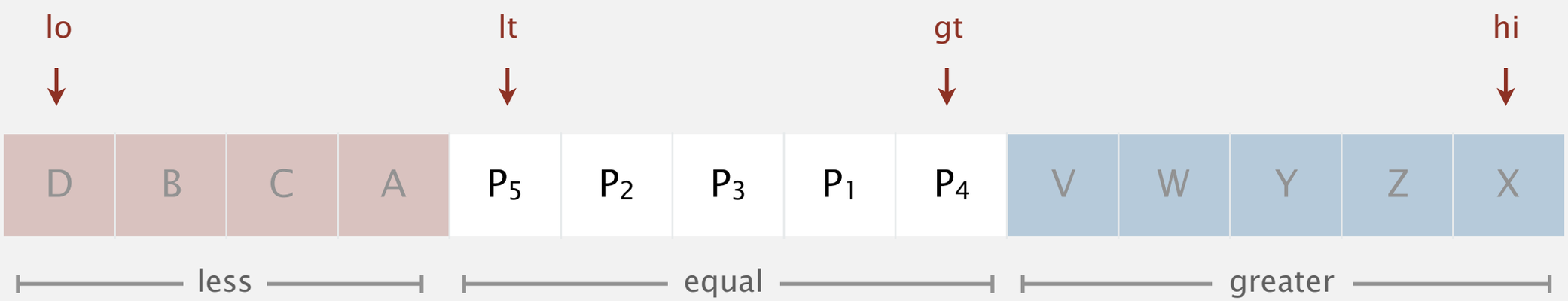


Dijkstra 3-way partitioning demo

- Let `v = a[lo]` be pivot.
- Scan `i` from left to right and compare `a[i]` to `v`.
  - less: exchange `a[lt]` with `a[i]`; increment both `lt` and `i`
  - greater: exchange `a[gt]` with `a[i]`; decrement `gt`
  - equal: increment `i`



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2.3 Partitioning Demos

- *Hoare 2-way partitioning*
- *Dijkstra 3-way partitioning*
- *Bentley–McIlroy 3-way partitioning*
- *dual-pivot partitioning*

Bentley–McIlroy 3-way partitioning demo

Phase I. Repeat until `i` and `j` pointers cross.

- Scan `i` from left to right so long as `(a[i] < a[lo])`.
- Scan `j` from right to left so long as `(a[j] > a[lo])`.
- Exchange `a[i]` with `a[j]`.
- If `(a[i] == a[lo])`, exchange `a[i]` with `a[p]` and increment `p`.
- If `(a[j] == a[lo])`, exchange `a[j]` with `a[q]` and decrement `q`.

Bentley–McIlroy 3-way partitioning demo

Phase I. Repeat until `i` and `j` pointers cross.

- Scan `i` from left to right so long as `(a[i] < a[lo])`.
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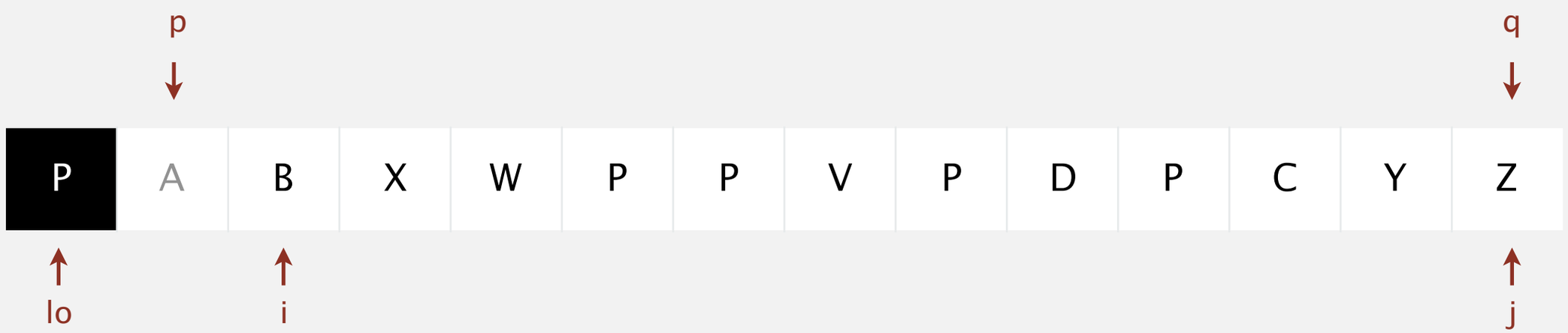

Bentley–McIlroy 3-way partitioning demo

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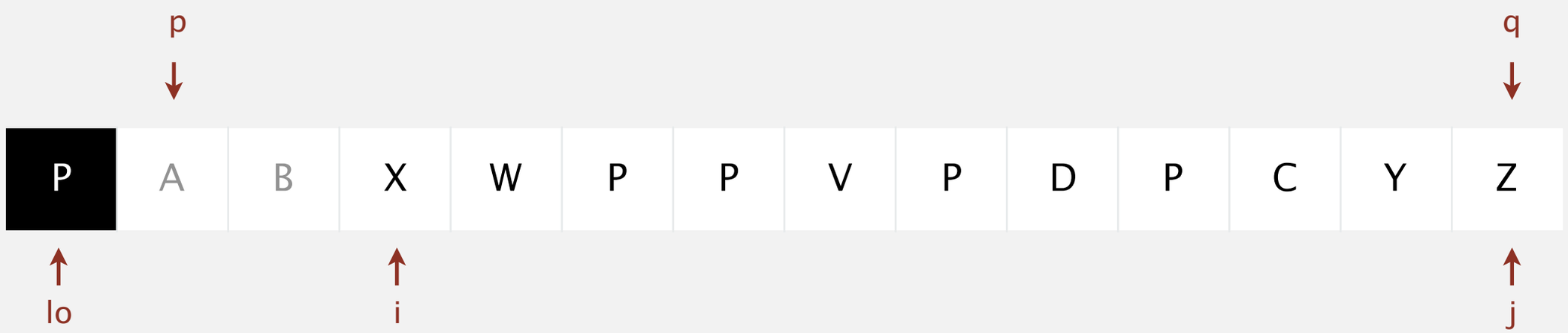

Bentley–McIlroy 3-way partitioning demo

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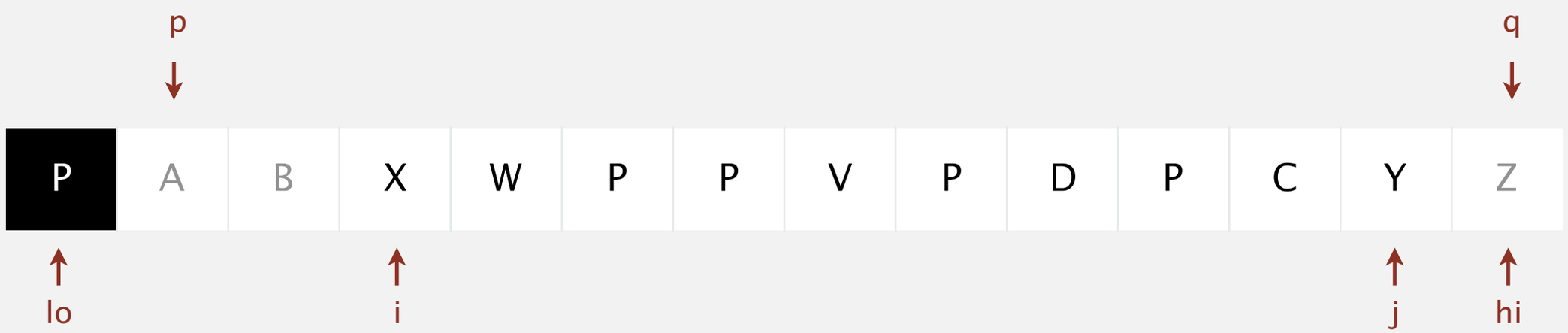

Bentley–McIlroy 3-way partitioning demo

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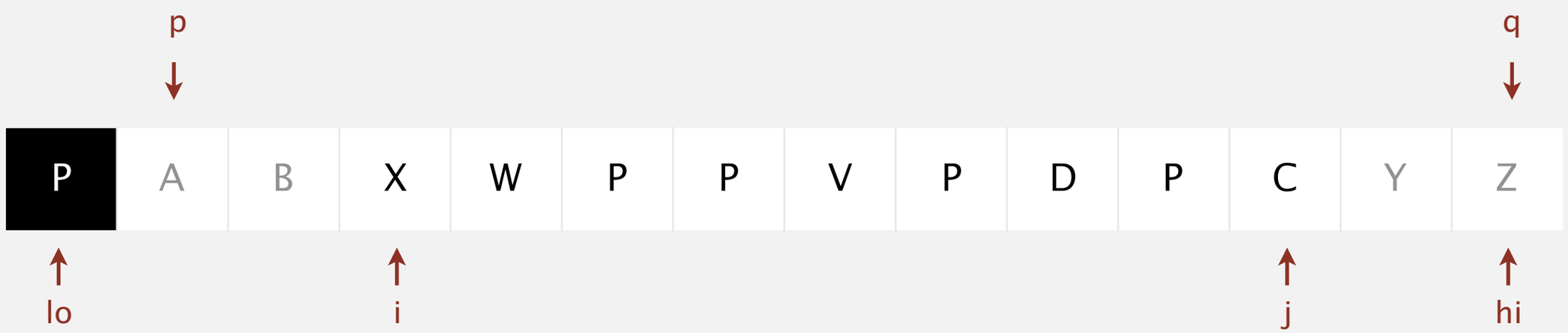

exchange `a[i]` with `a[j]`

Bentley–McIlroy 3-way partitioning demo

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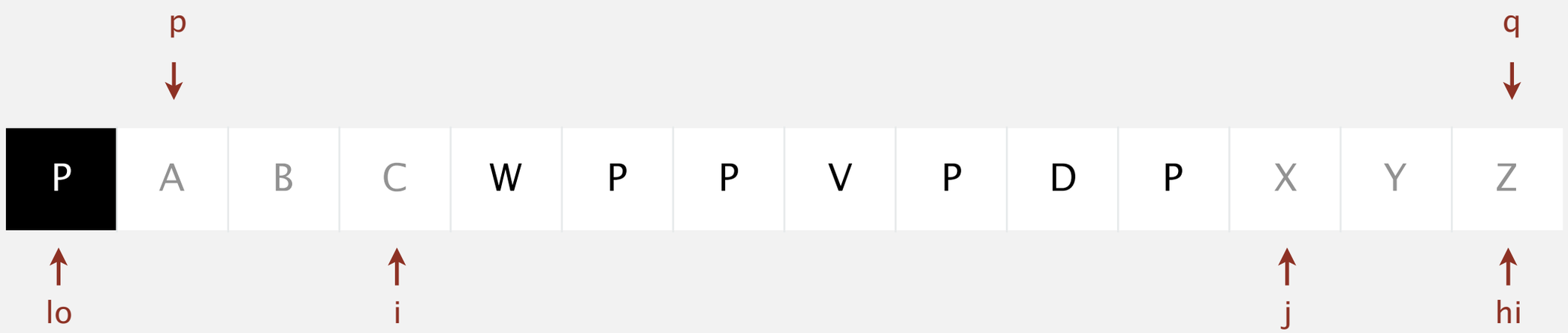

Bentley–McIlroy 3-way partitioning demo

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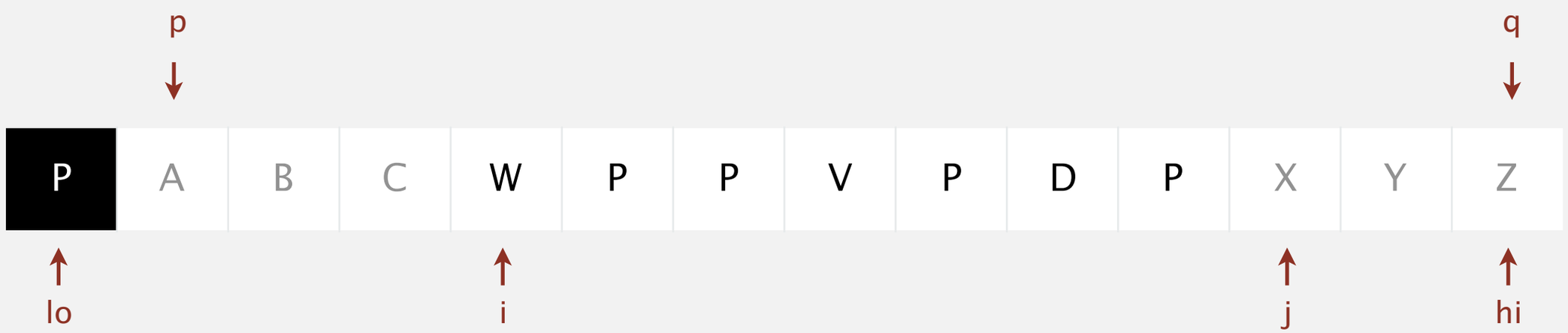

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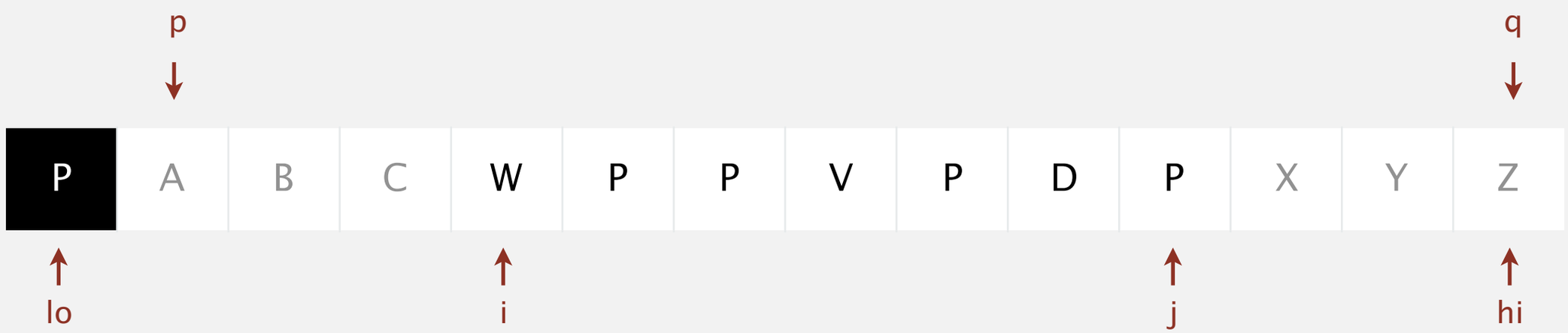

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Bentley–McIlroy 3-way partitioning demo

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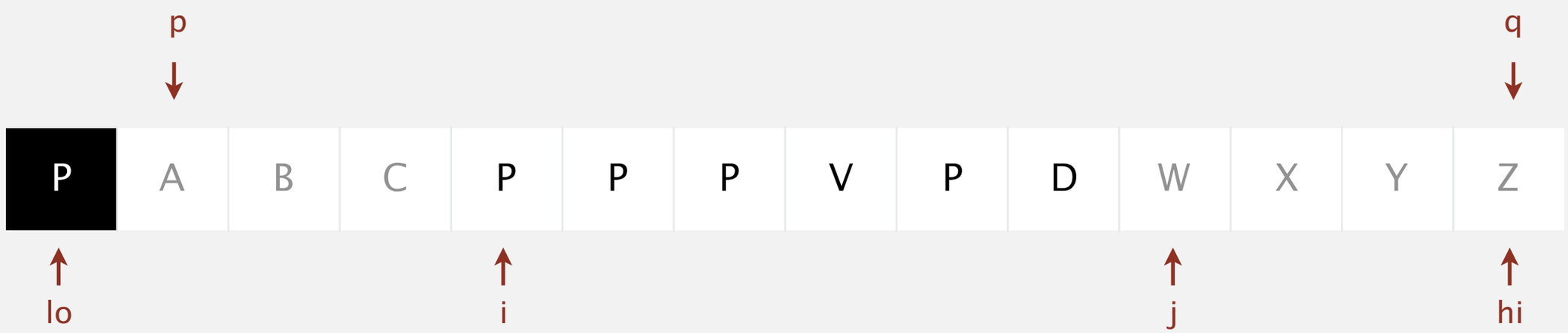

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Bentley–McIlroy 3-way partitioning demo

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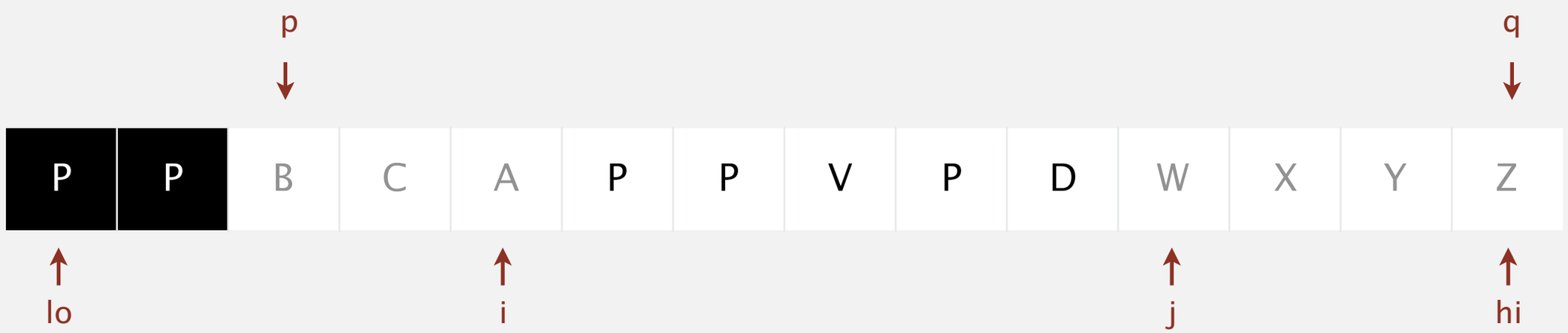

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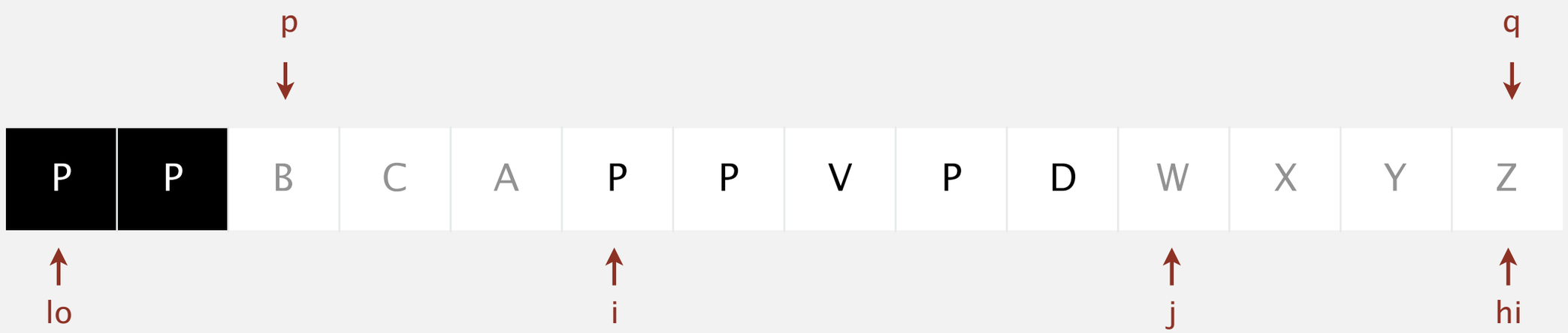

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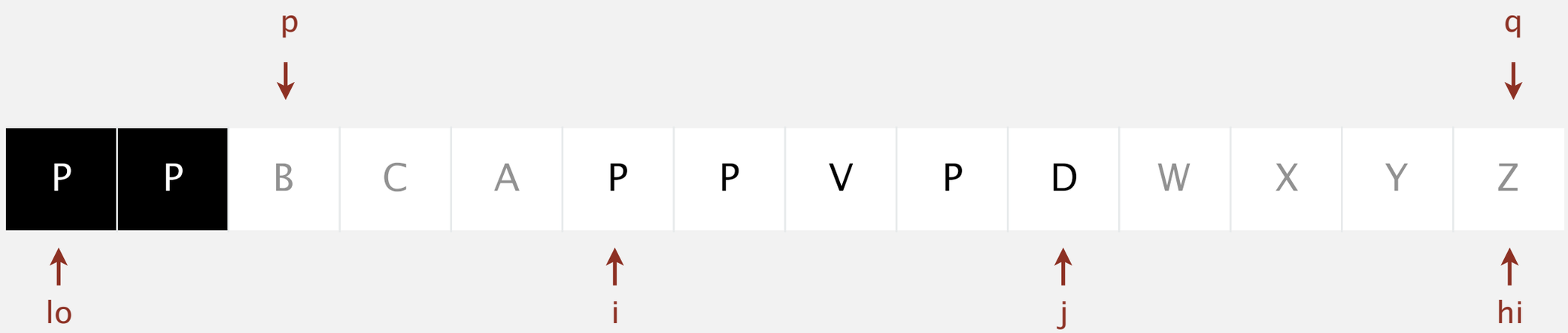

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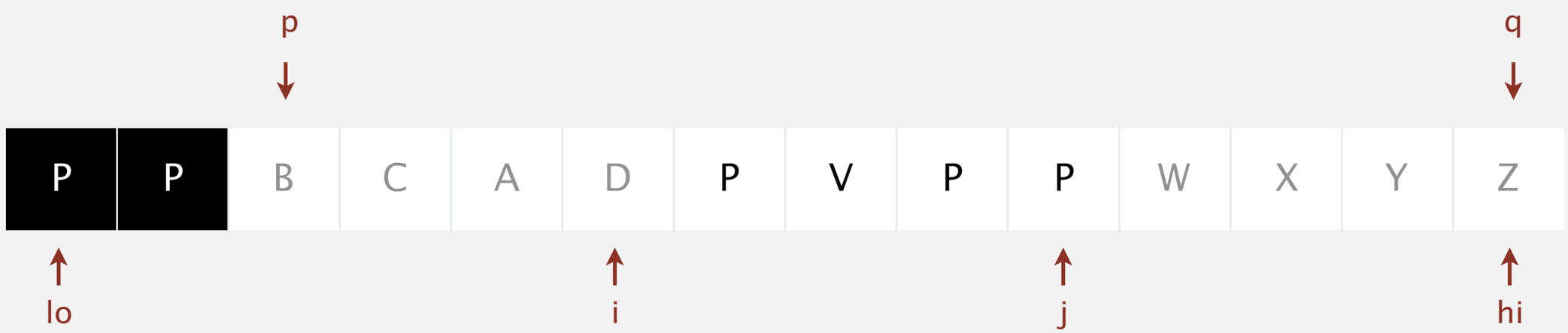

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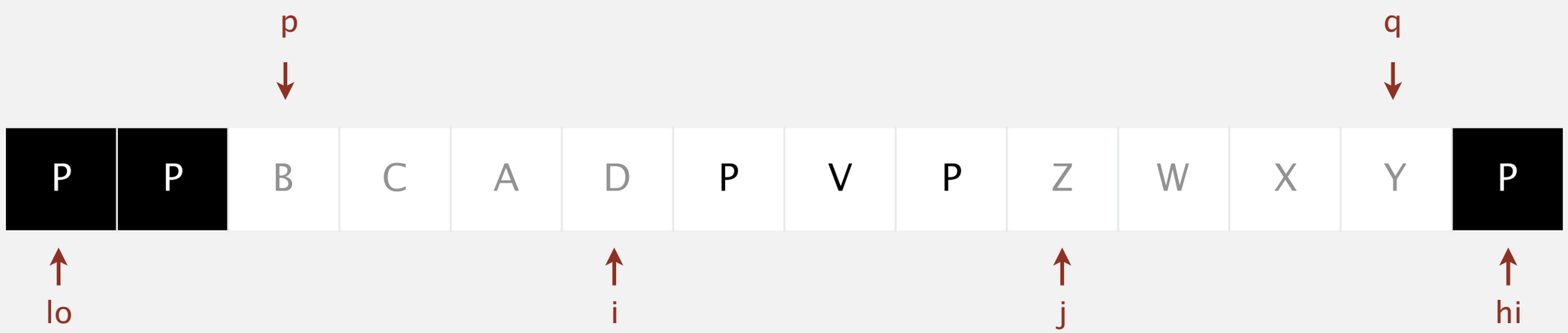

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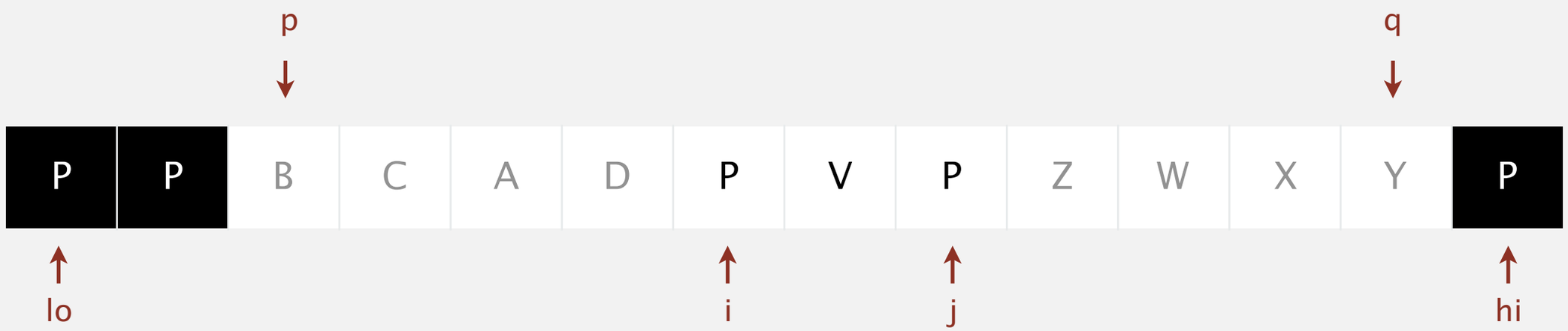

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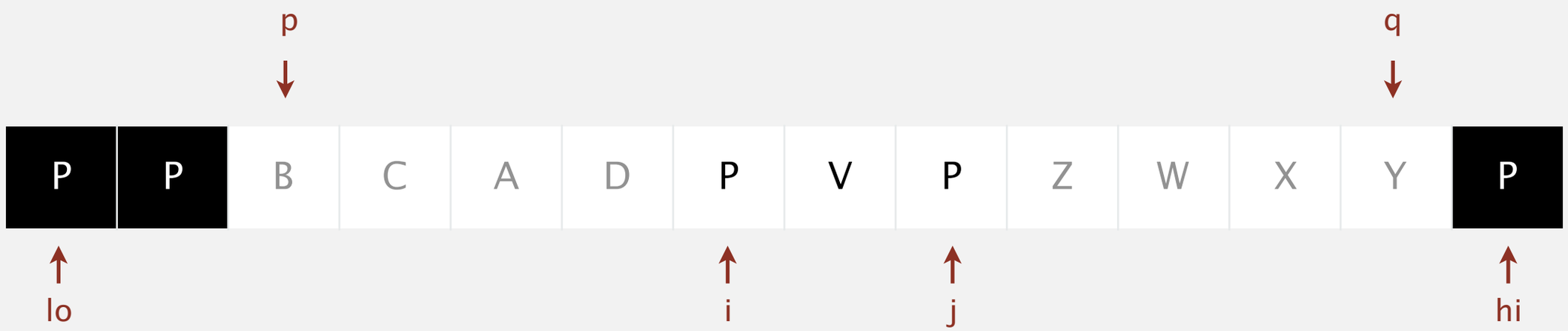

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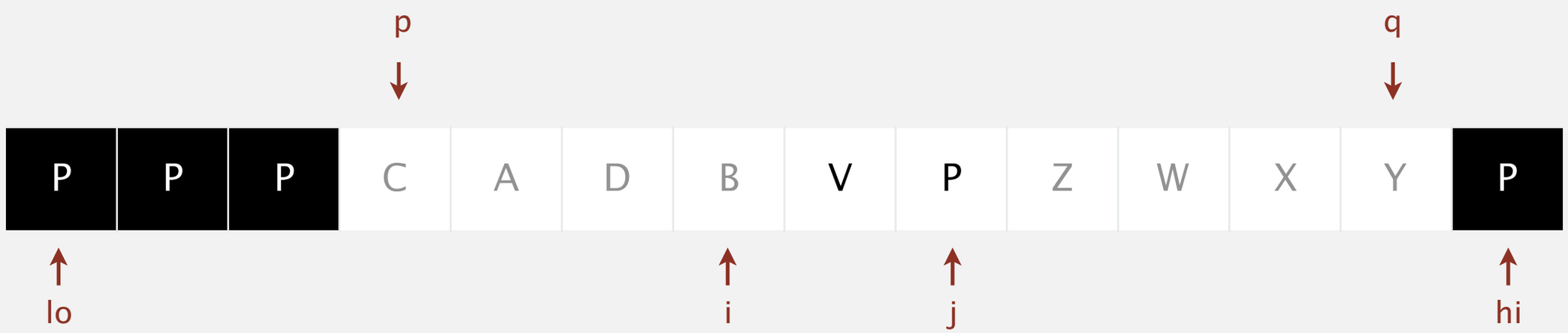

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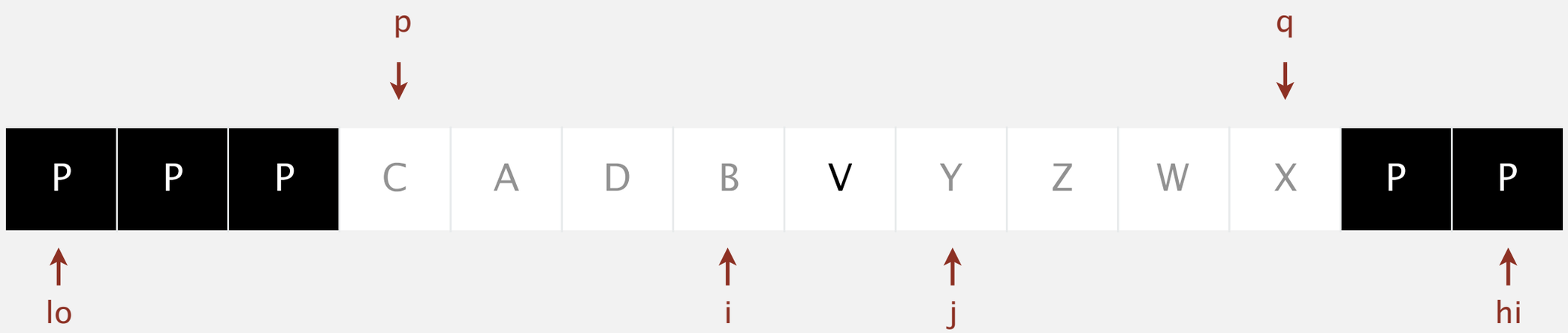

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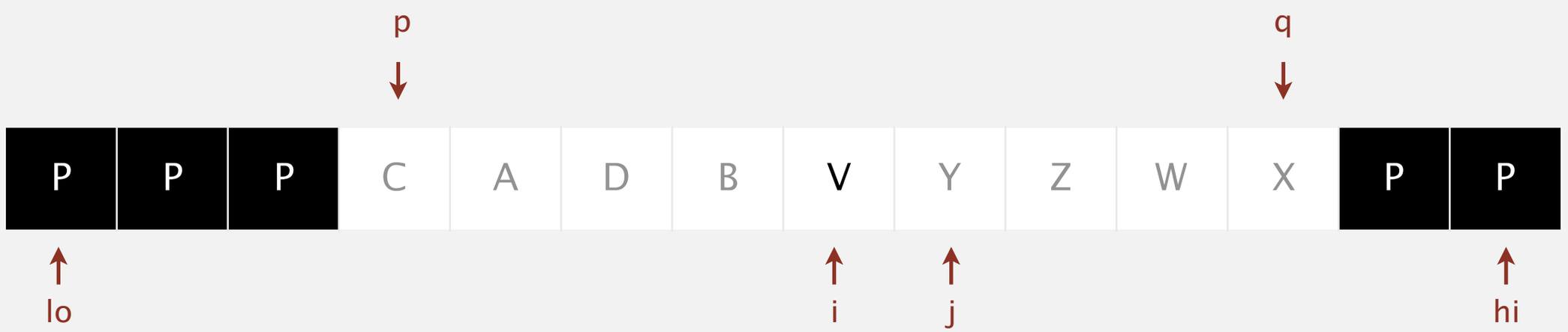

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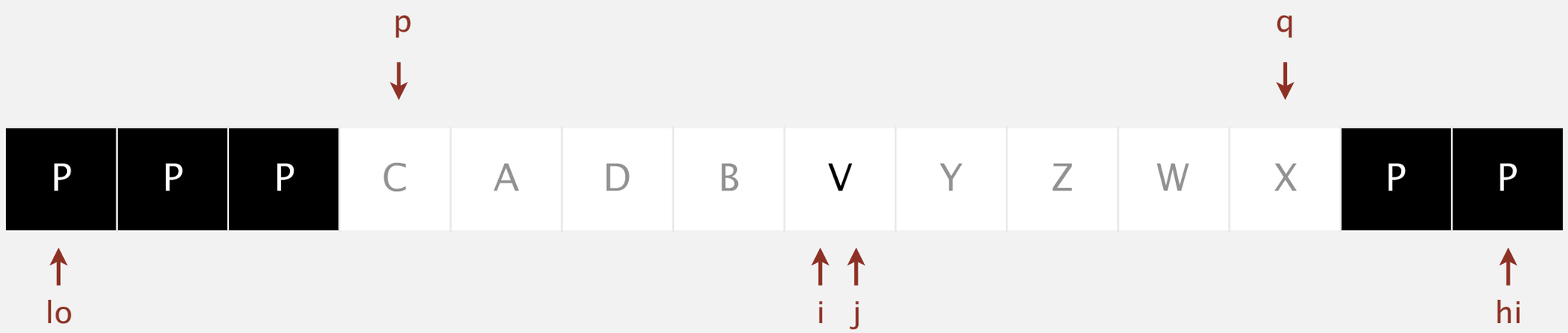

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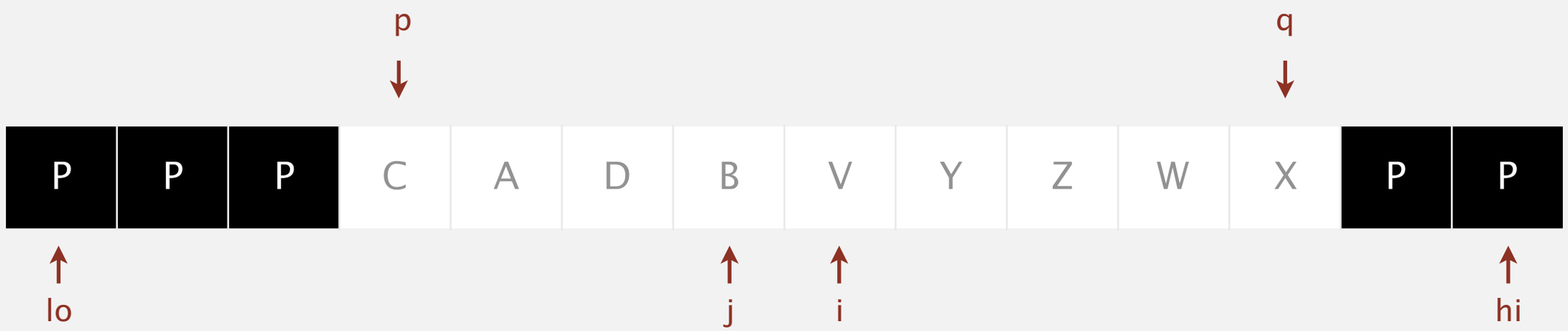
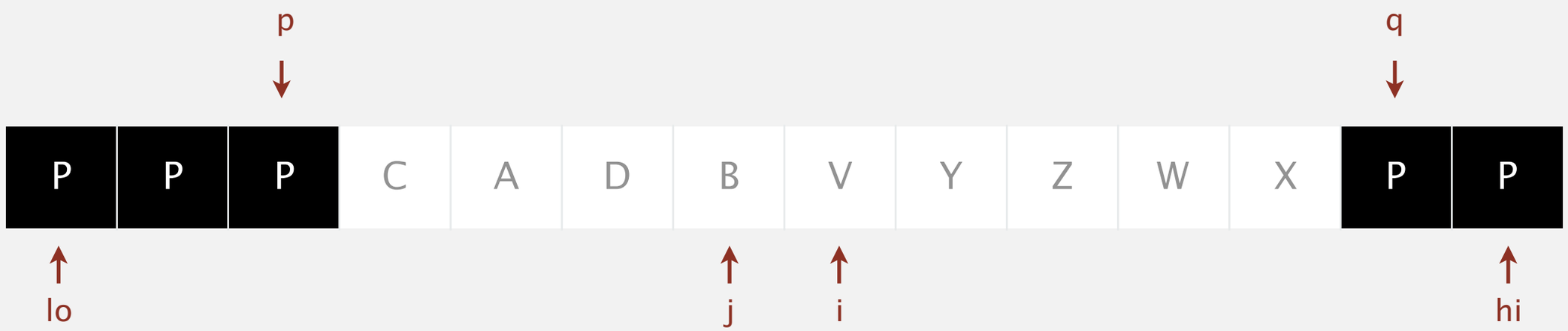


pointers cross

Bentley–McIlroy 3-way partitioning demo

Phase II. Swap equal keys to the center.

- Scan `j` and `p` from right to left and exchange `a[j]` with `a[p]`.
- Scan `i` and `q` from left to right and exchange `a[i]` with `a[q]`.



exchange `a[j]` with `a[p]`

Bentley–McIlroy 3-way partitioning demo

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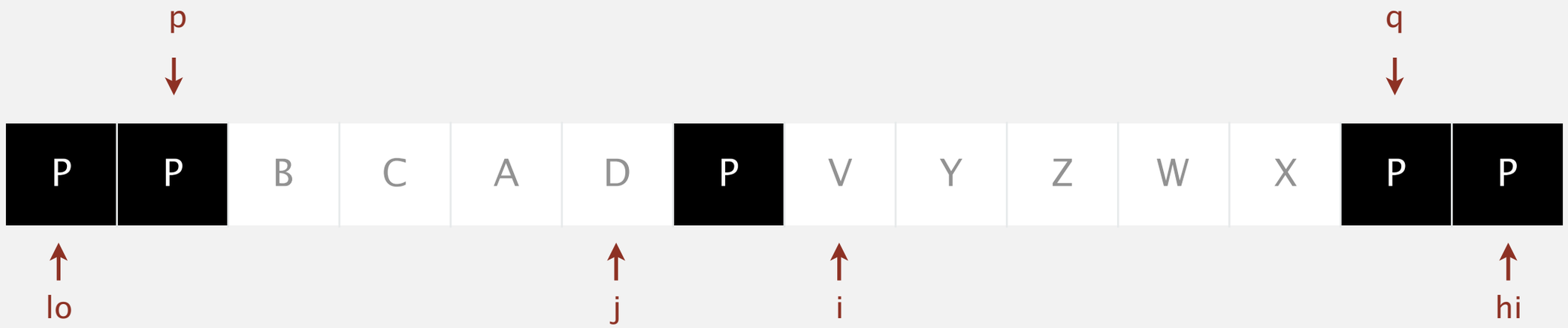

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Bentley–McIlroy 3-way partitioning demo

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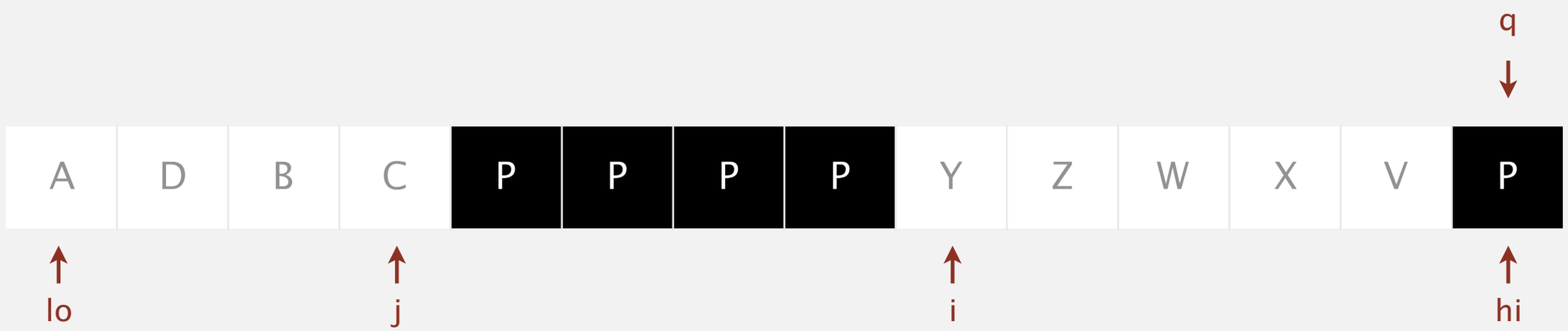

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Bentley–McIlroy 3-way partitioning demo

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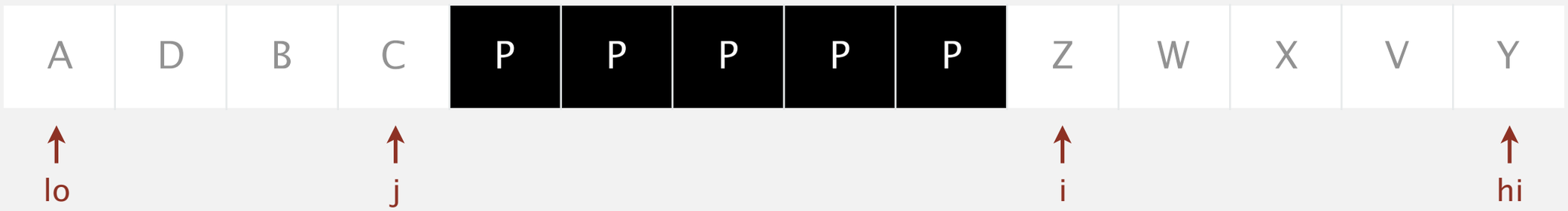

3-way partitioned

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2.3 Partitioning Demos

- *Hoare 2-way partitioning*
- *Dijkstra 3-way partitioning*
- *Bentley–McIlroy 3-way partitioning*
- *dual-pivot partitioning*

Dual-pivot partitioning demo

Initialization.

- Choose `a[lo]` and `a[hi]` as partitioning items.
- Exchange if necessary to ensure `a[lo]` $\leq$ `a[hi]`.

exchange a[lo] and a[hi]

Dual-pivot partitioning demo

Initialization.

- Choose `a[lo]` and `a[hi]` as partitioning items.
- Exchange if necessary to ensure `a[lo]` $\leq$ `a[hi]`.

Dual-pivot partitioning demo

Main loop. Repeat until `i` and `gt` pointers cross.

- If `(a[i] < a[lo])`, exchange `a[i]` with `a[lt]` and increment `lt` and `i`.
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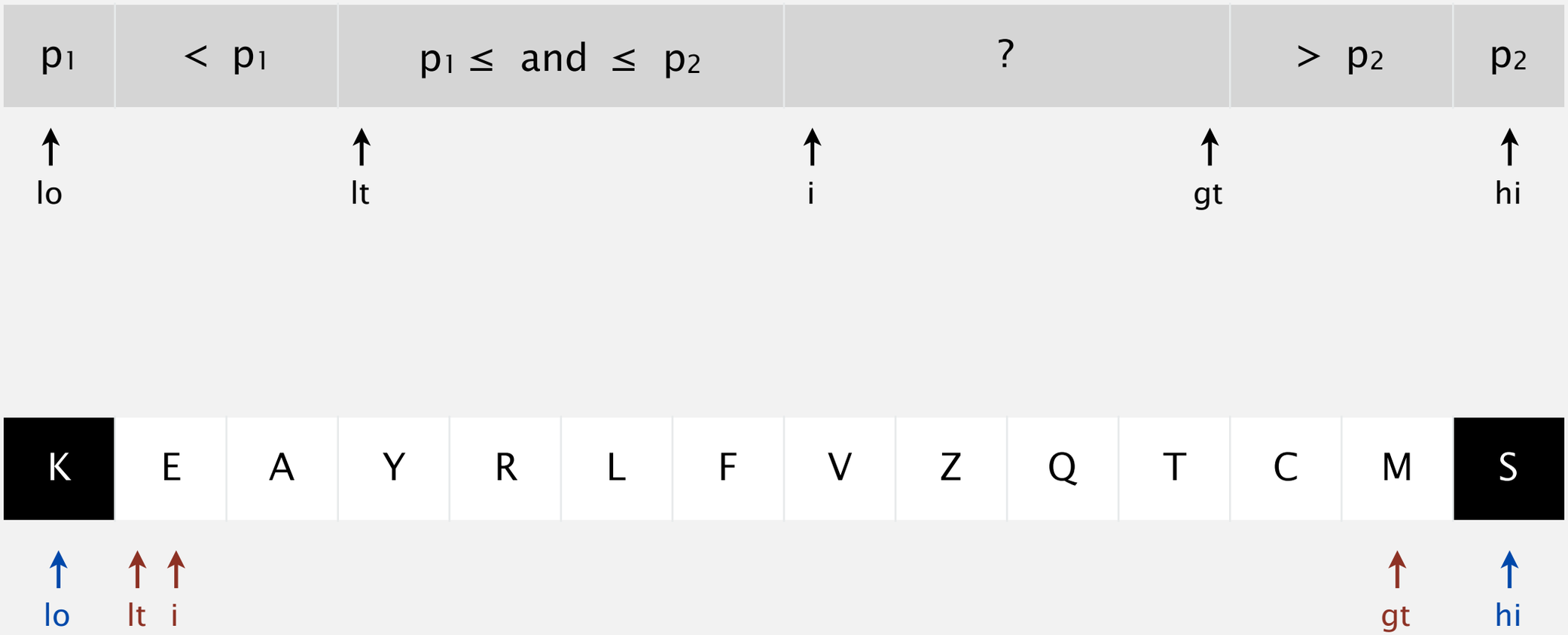

exchange a[i] and a[lt]; increment lt and i

Dual-pivot partitioning demo

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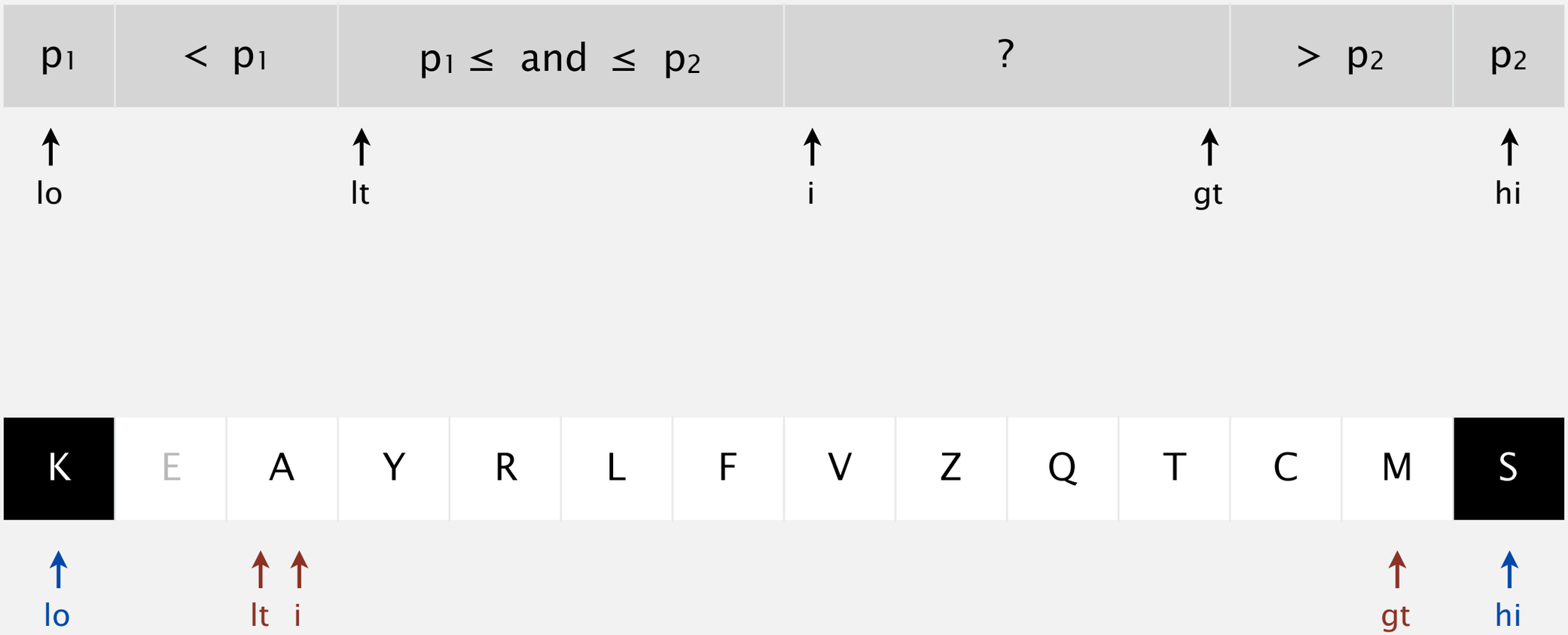

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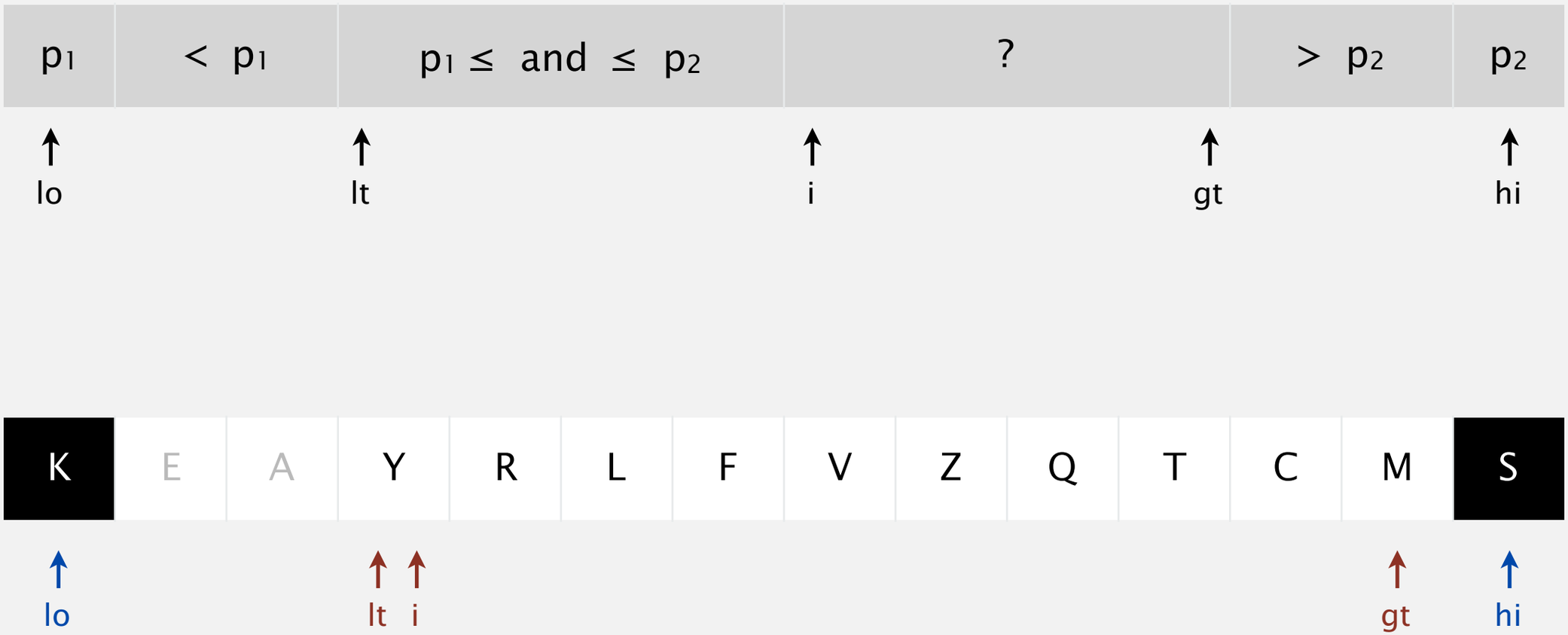

exchange a[i] and a[gt]; decrement gt

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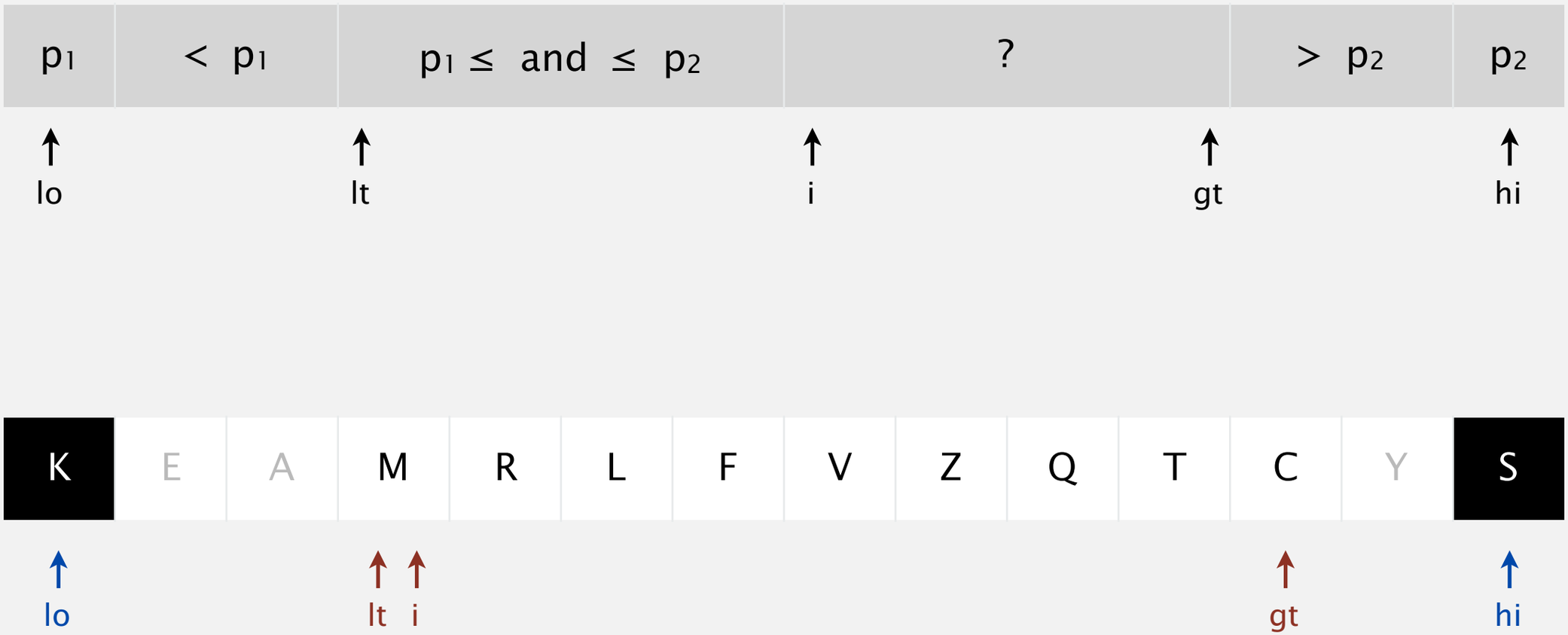

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Dual-pivot partitioning demo

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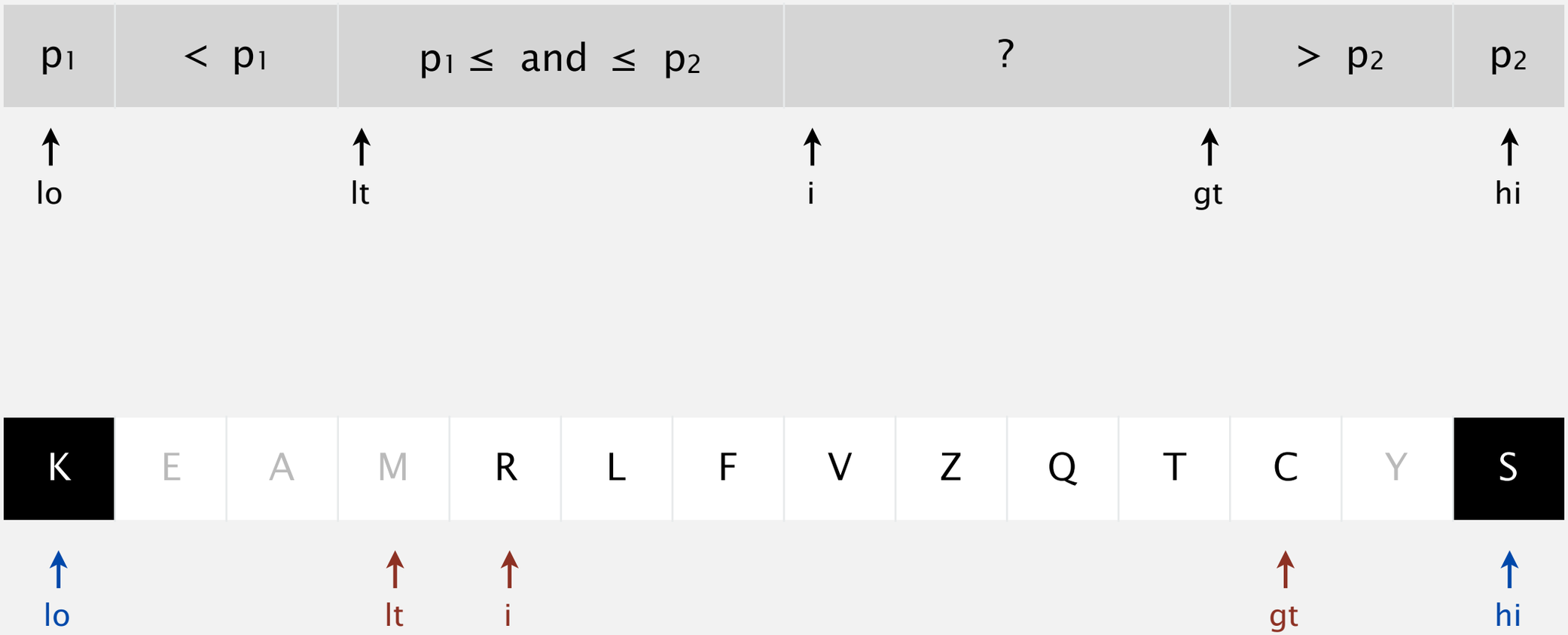

Dual-pivot partitioning demo

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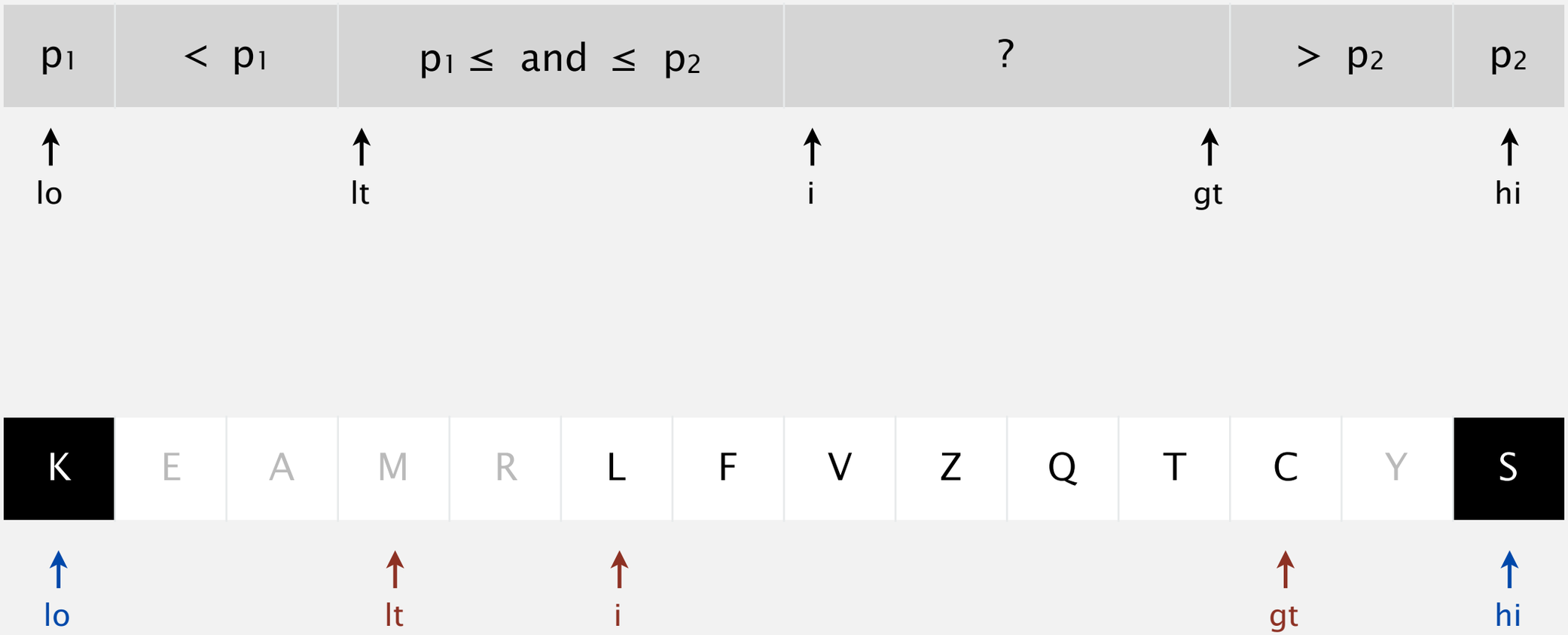

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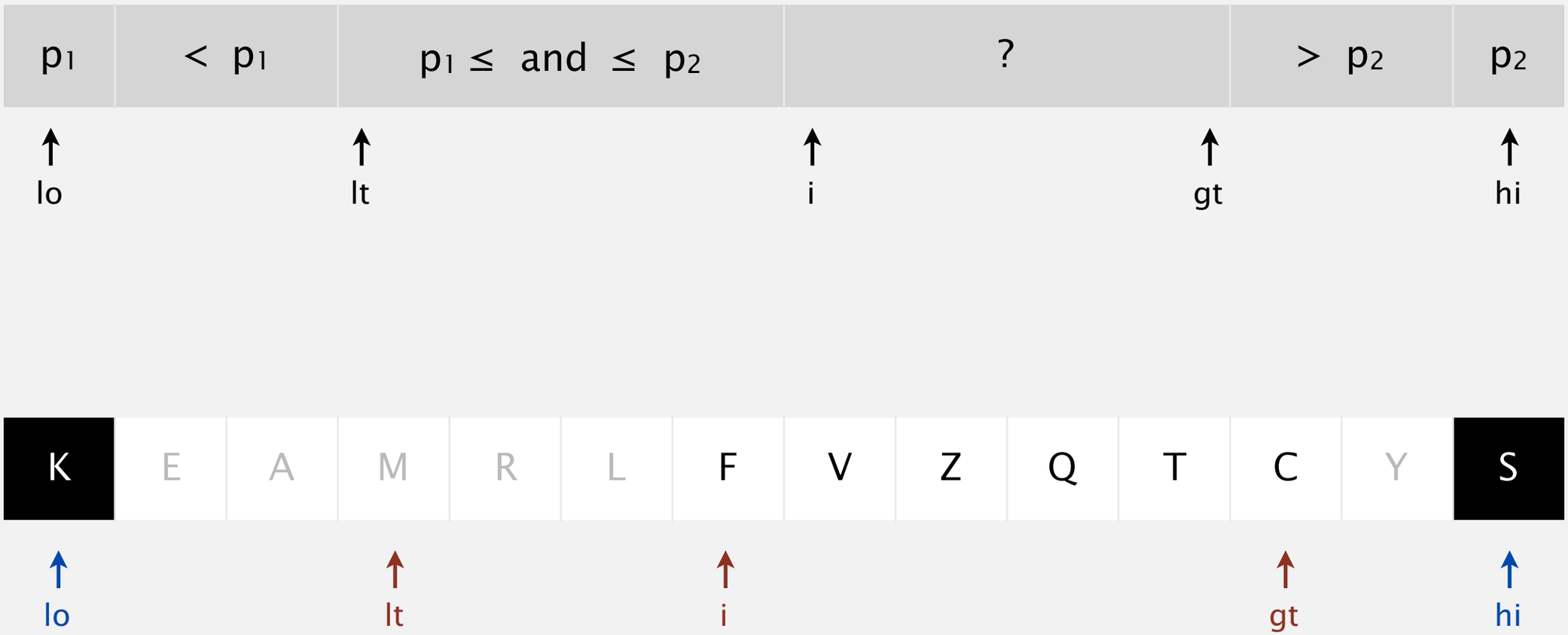

exchange a[i] and a[lt]; increment lt and i

Dual-pivot partitioning demo

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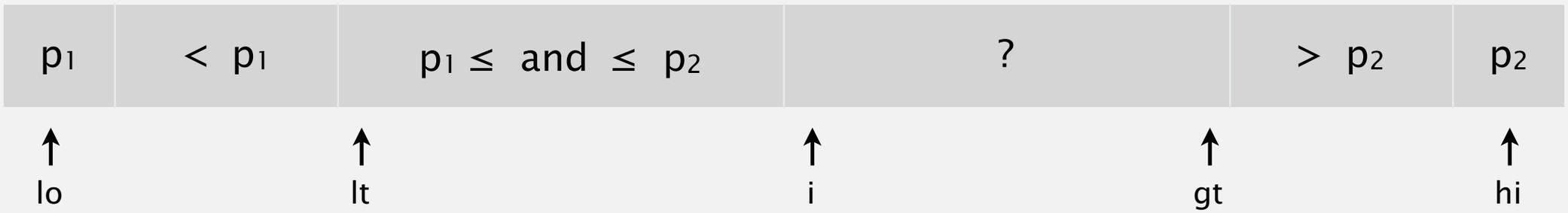

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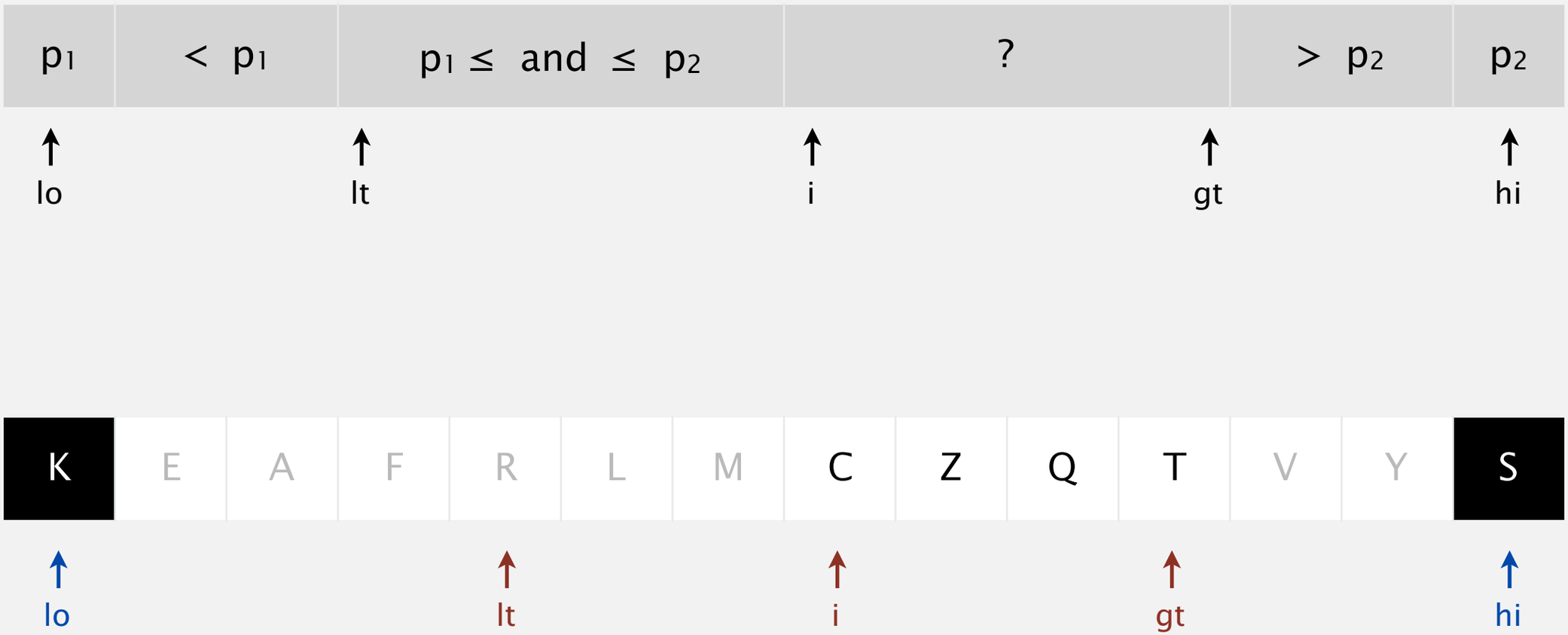

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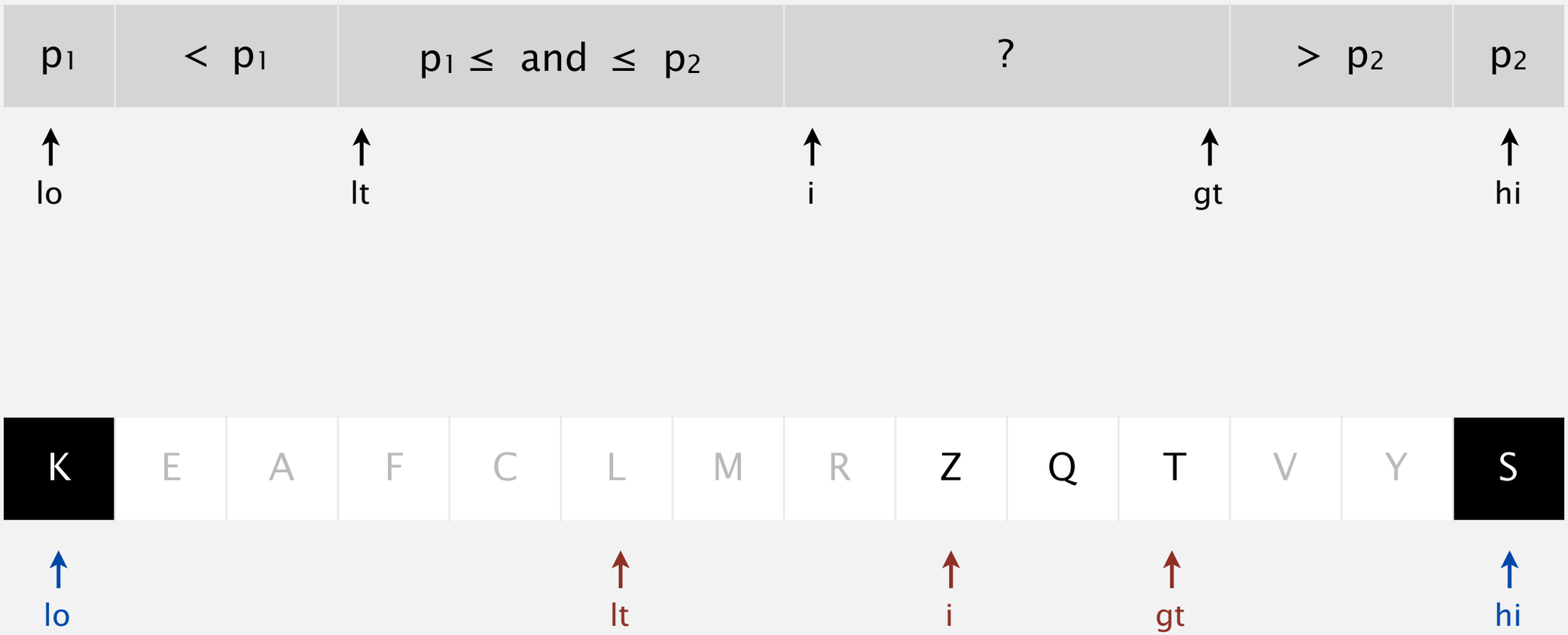

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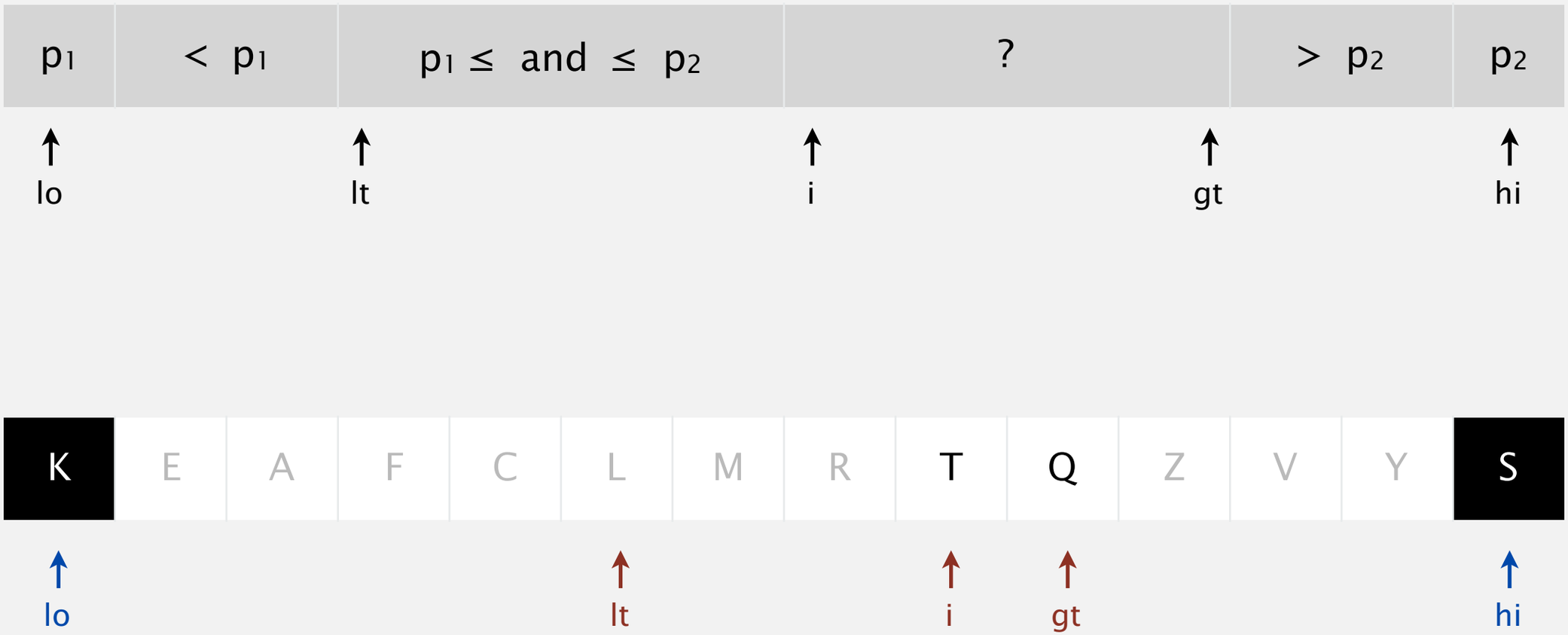

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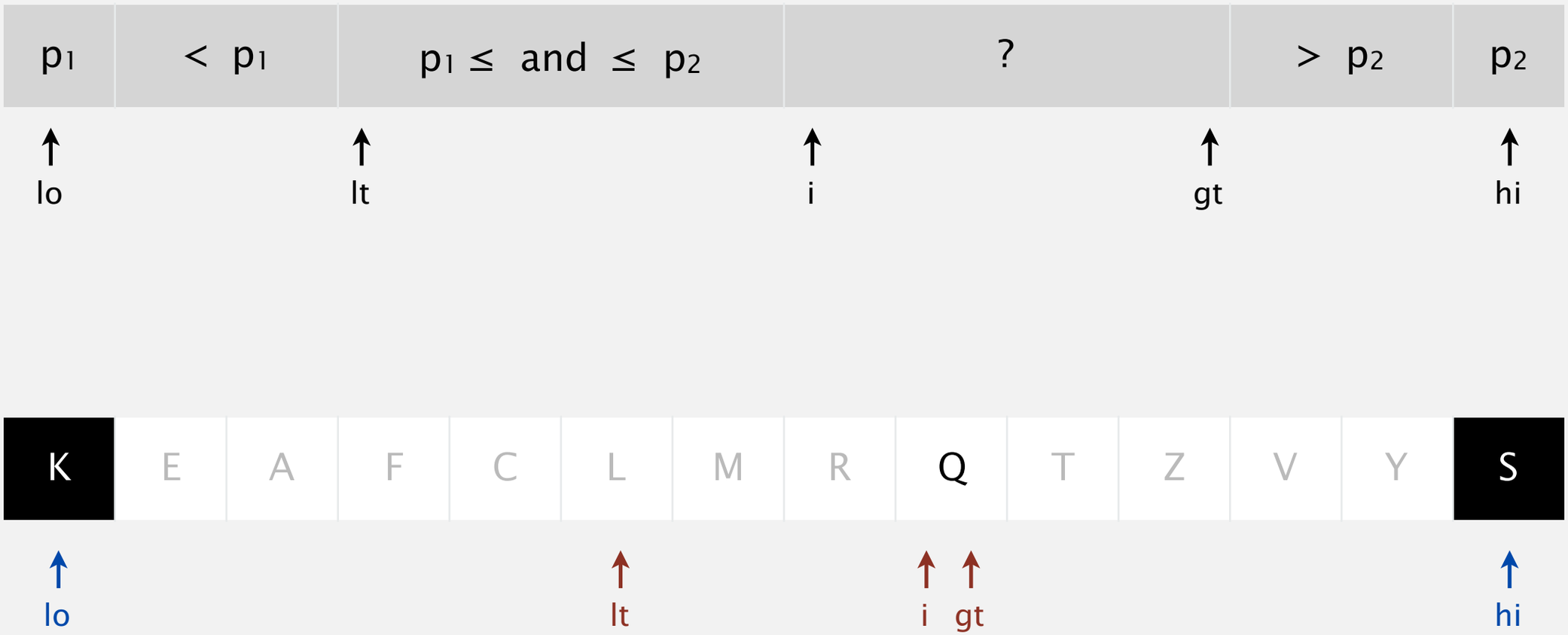

Dual-pivot partitioning demo

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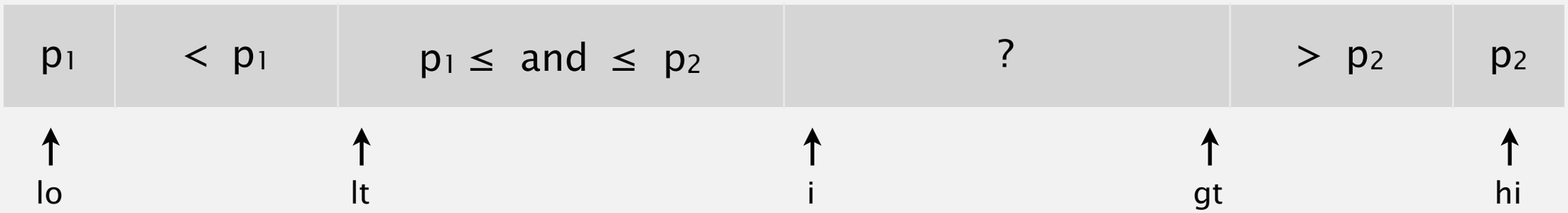
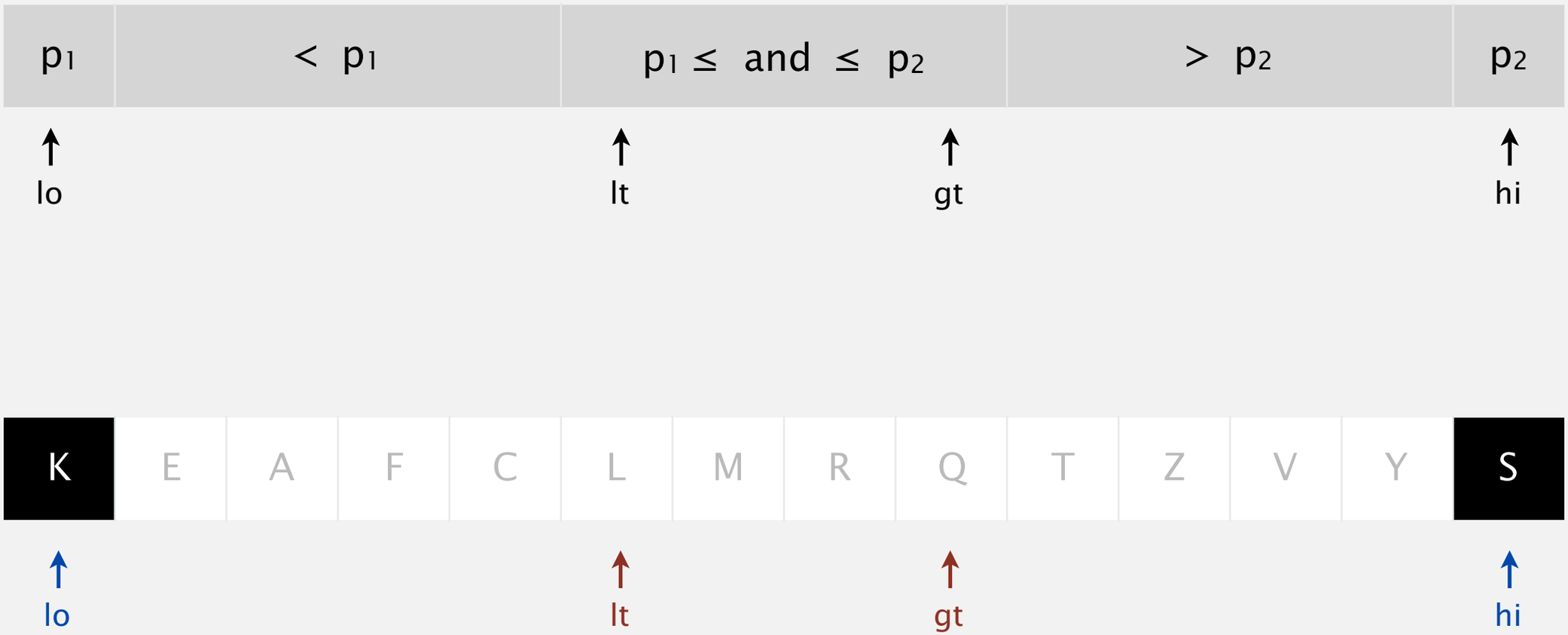


stop when pointers cross

Dual-pivot partitioning demo

Finalize.

- Exchange `a[lo]` with `a[--lt]`.
- Exchange `a[hi]` with `a[++gt]`.



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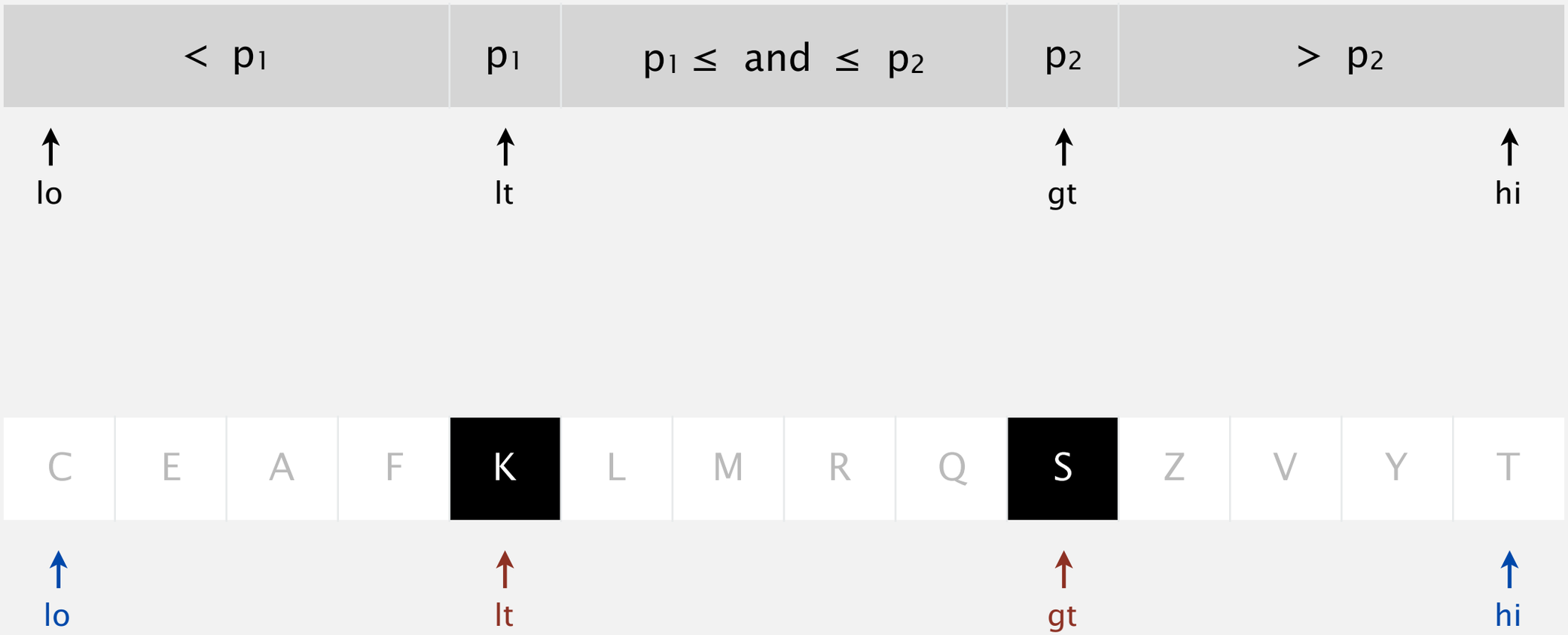


3-way partitioned

https://algs4.cs.princeton.edu

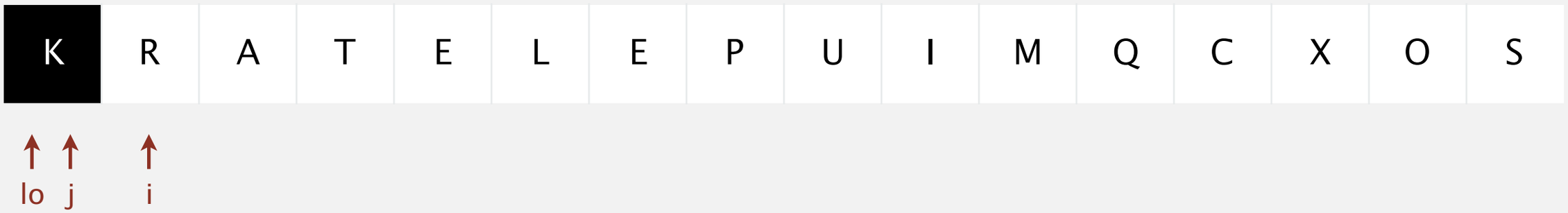
2.3 Partitioning Demos

- *Hoare 2-way partitioning*
- *Dijkstra 3-way partitioning*
- *Bentley–McIlroy 3-way partitioning*
- *dual-pivot partitioning*
- *Lomuto 2-way partitioning*

Lomuto partitioning demo

For `i = lo+1` to `hi`:

- If `a[i] < a[lo]`:
  - increment `j`
  - exchange `a[i]` with `a[j]`.



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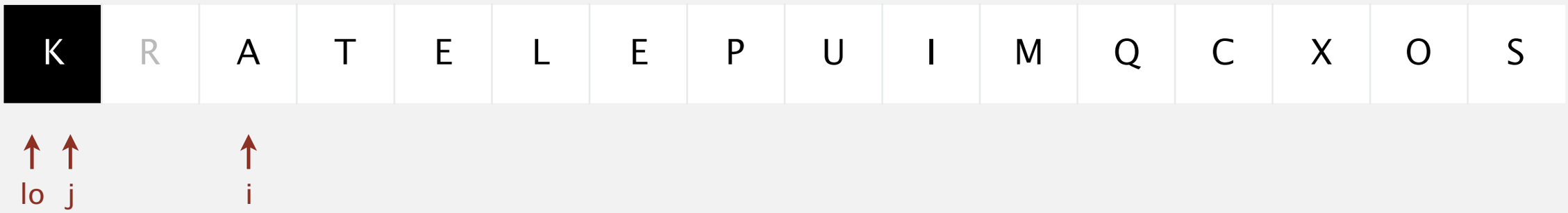

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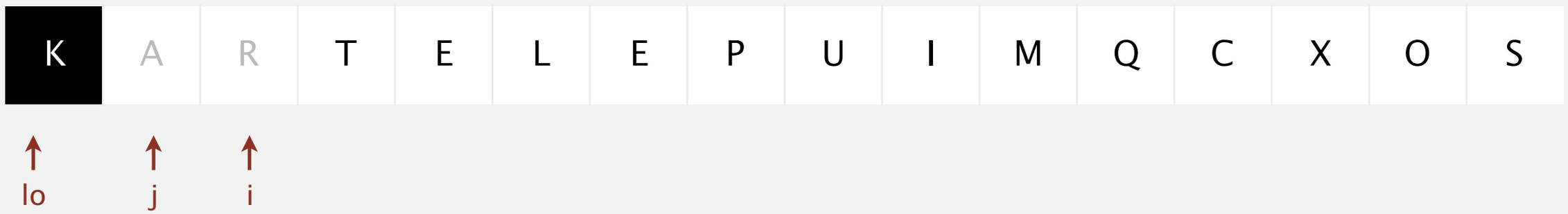

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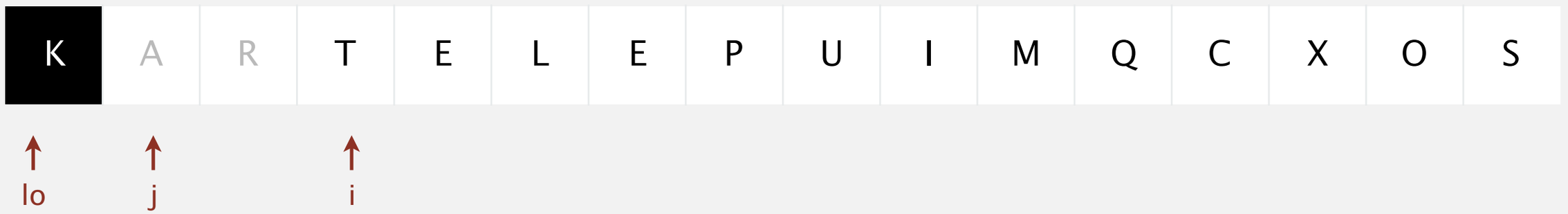

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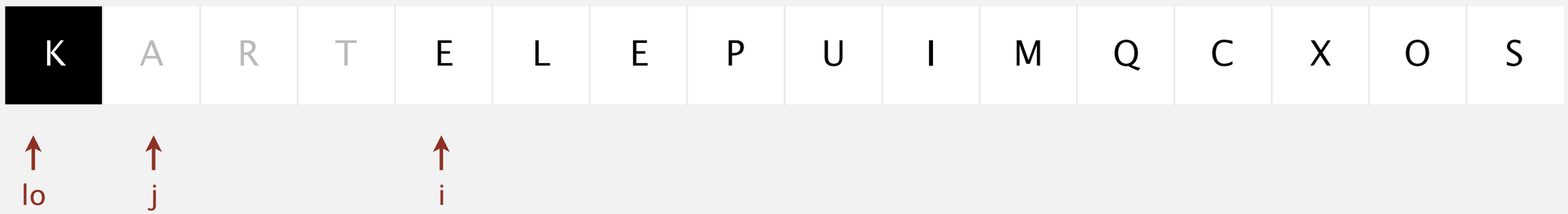

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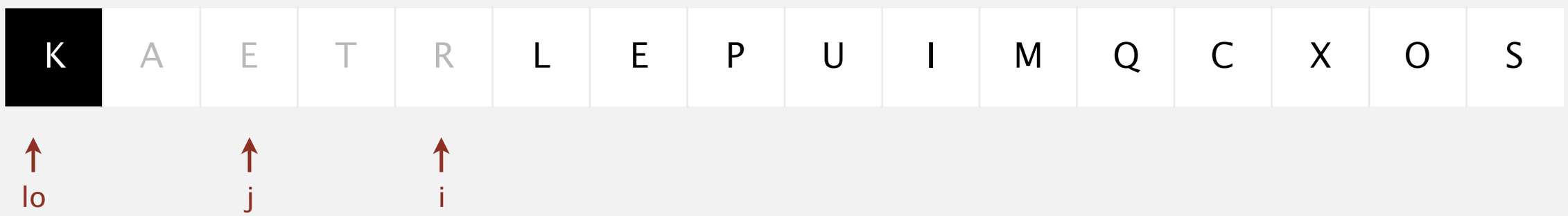

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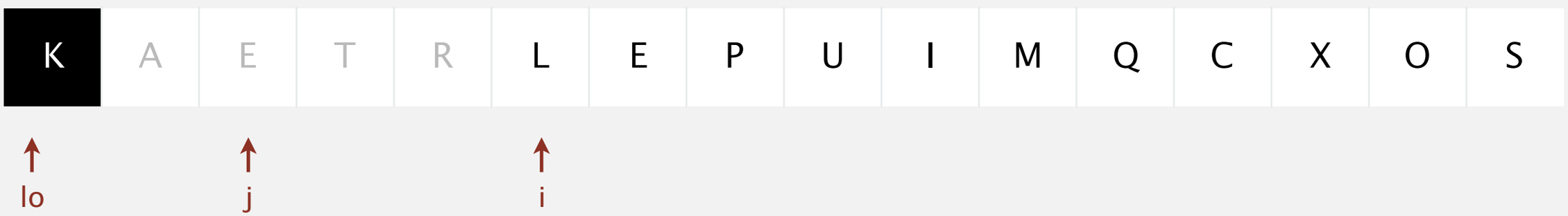

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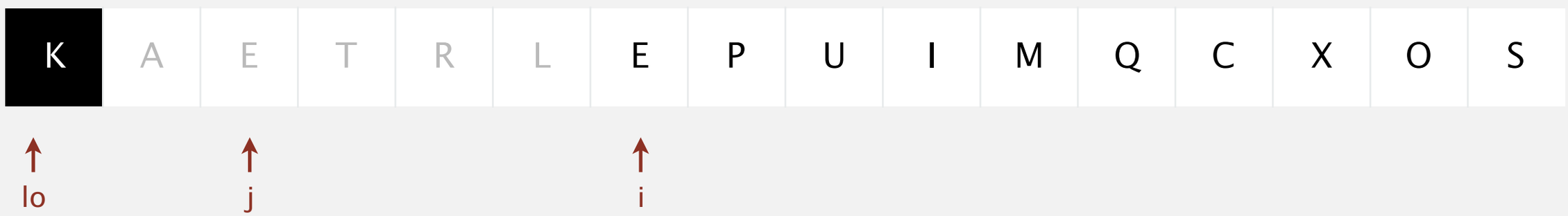

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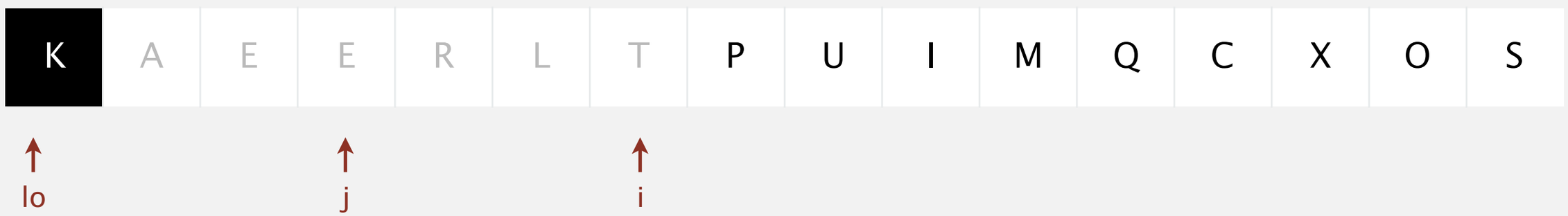

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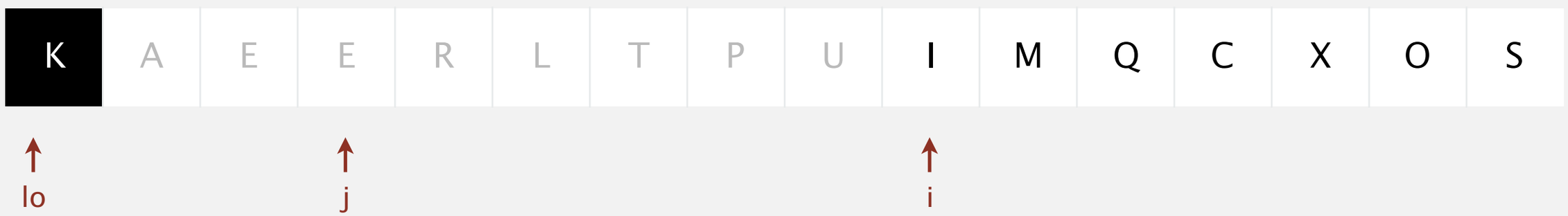

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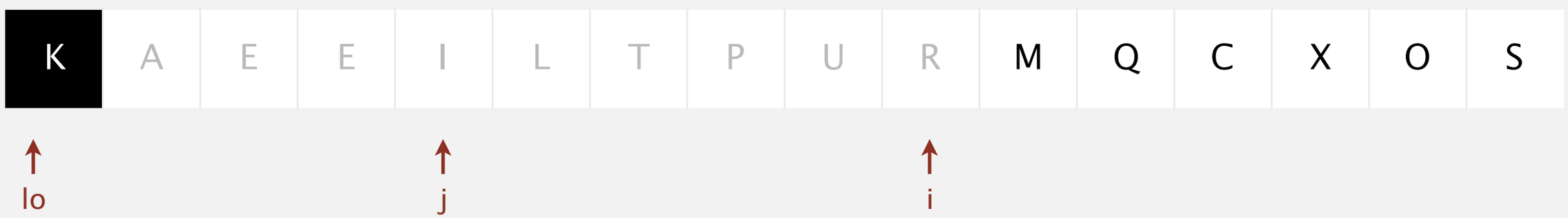

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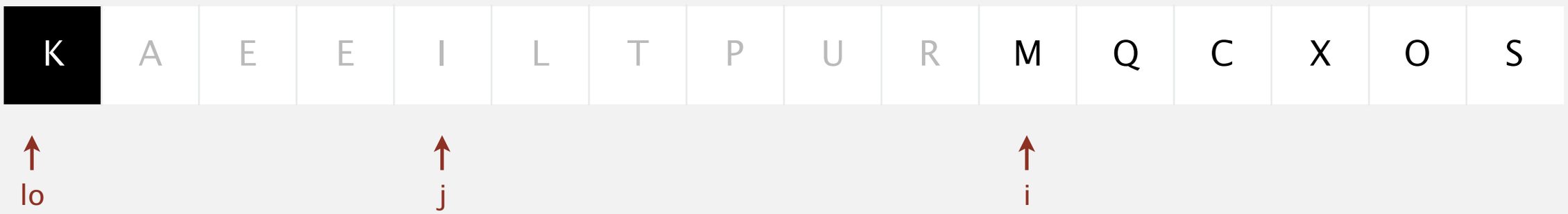

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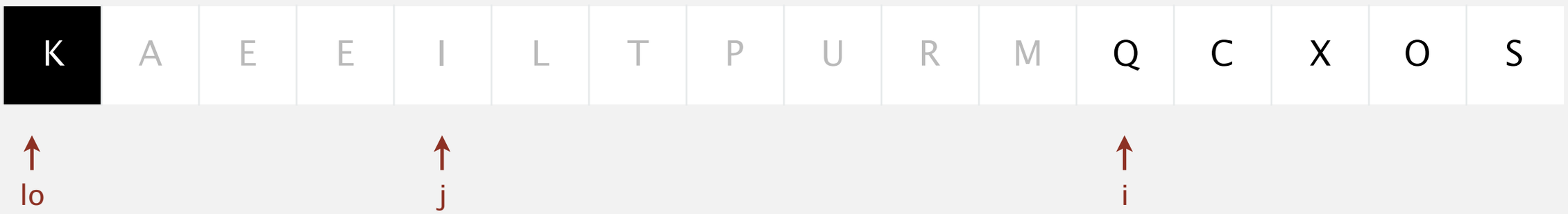

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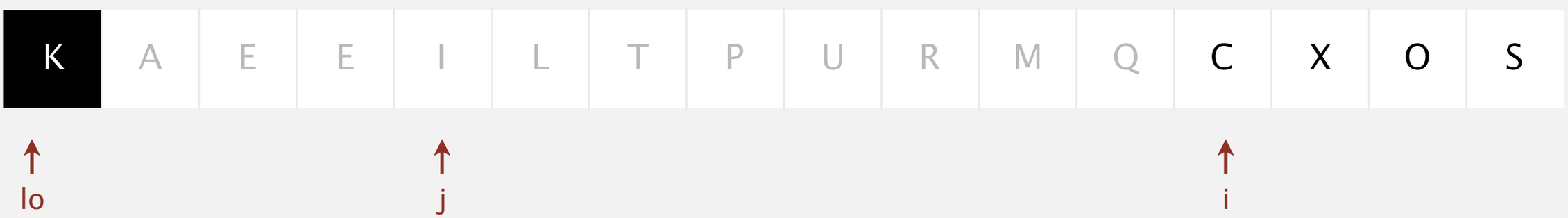

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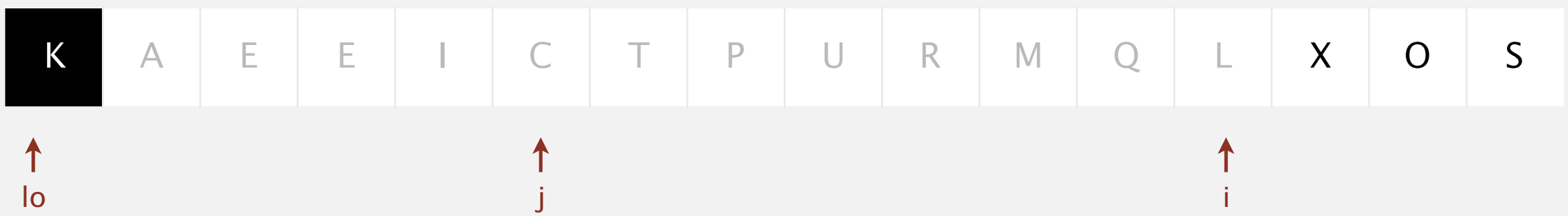

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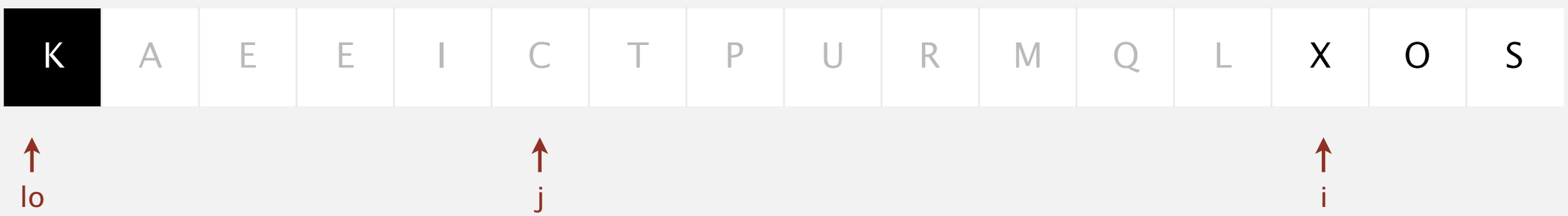

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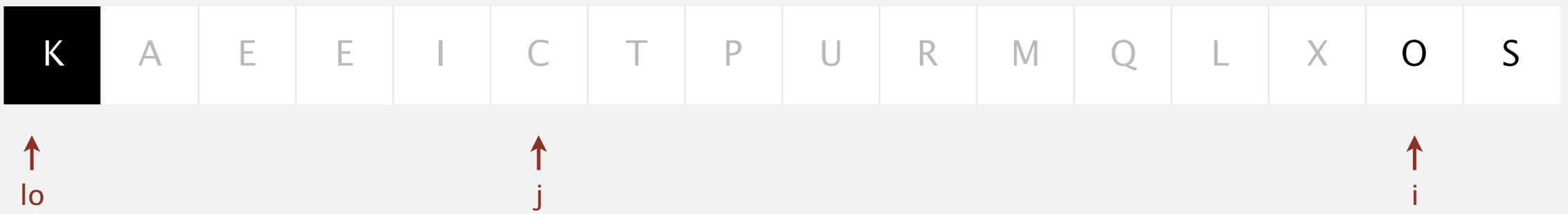

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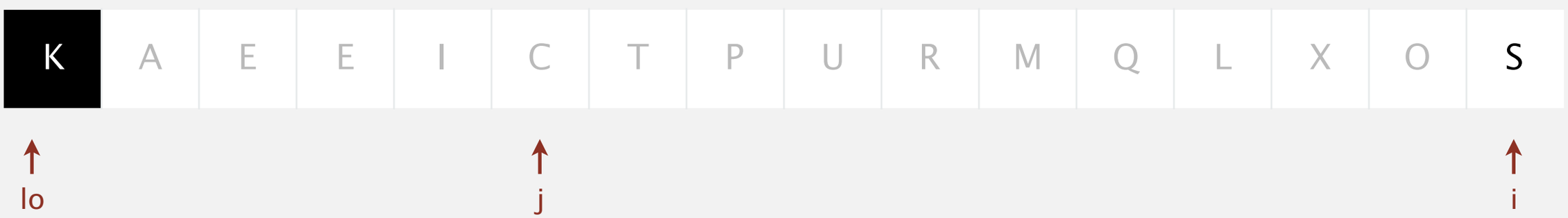

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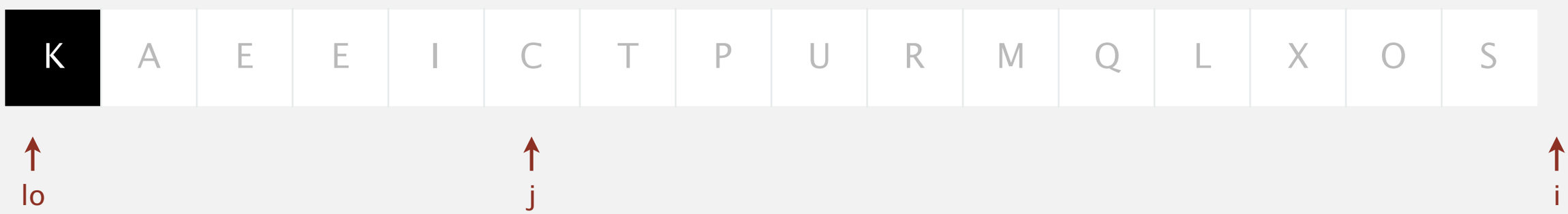

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