Efficient renaming in Conflict-free Replicated Data Types (CRDTs)

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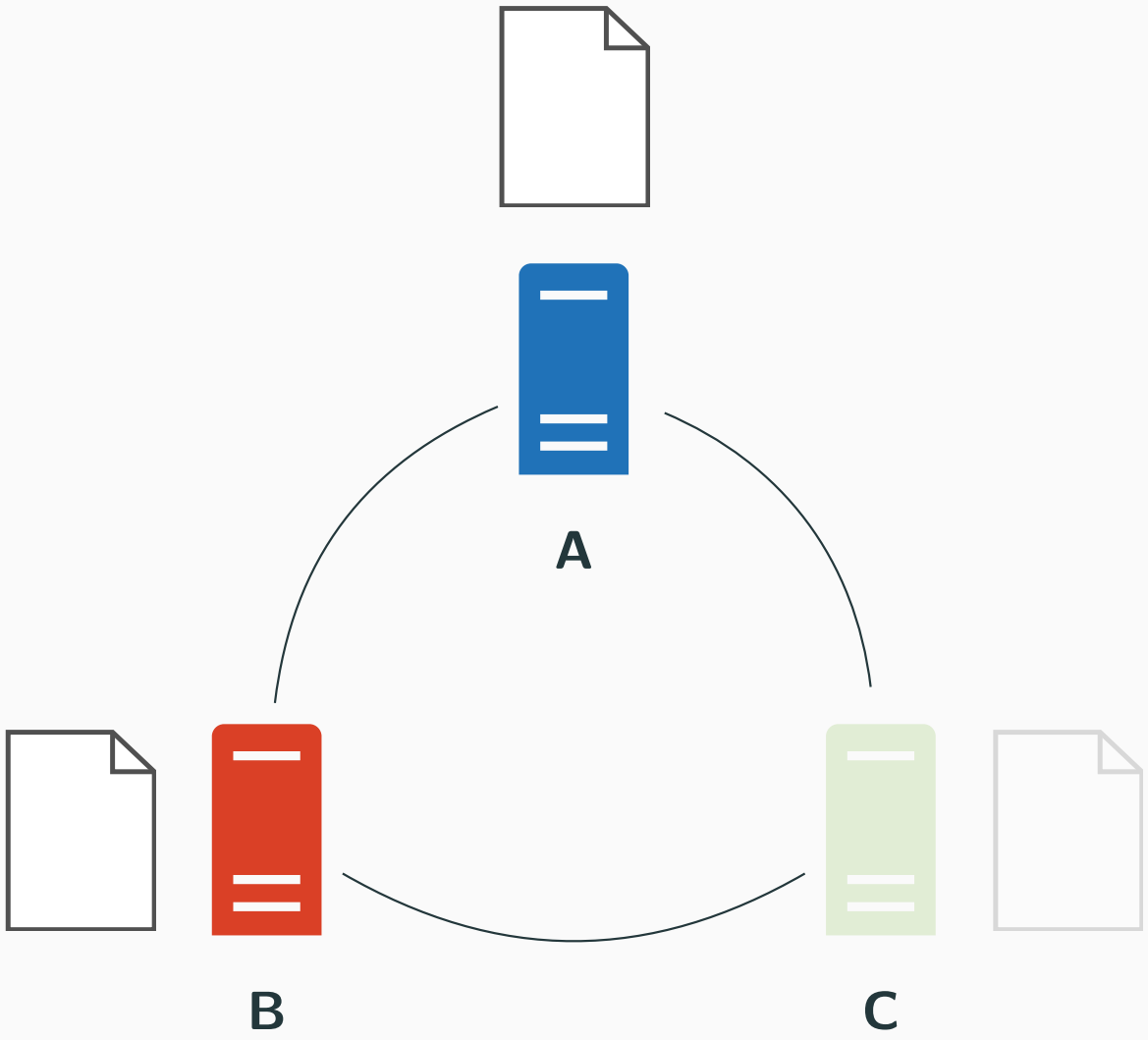
Conflict-free Replicated Data Types (CRDTs) [3]



- Replicated data structure

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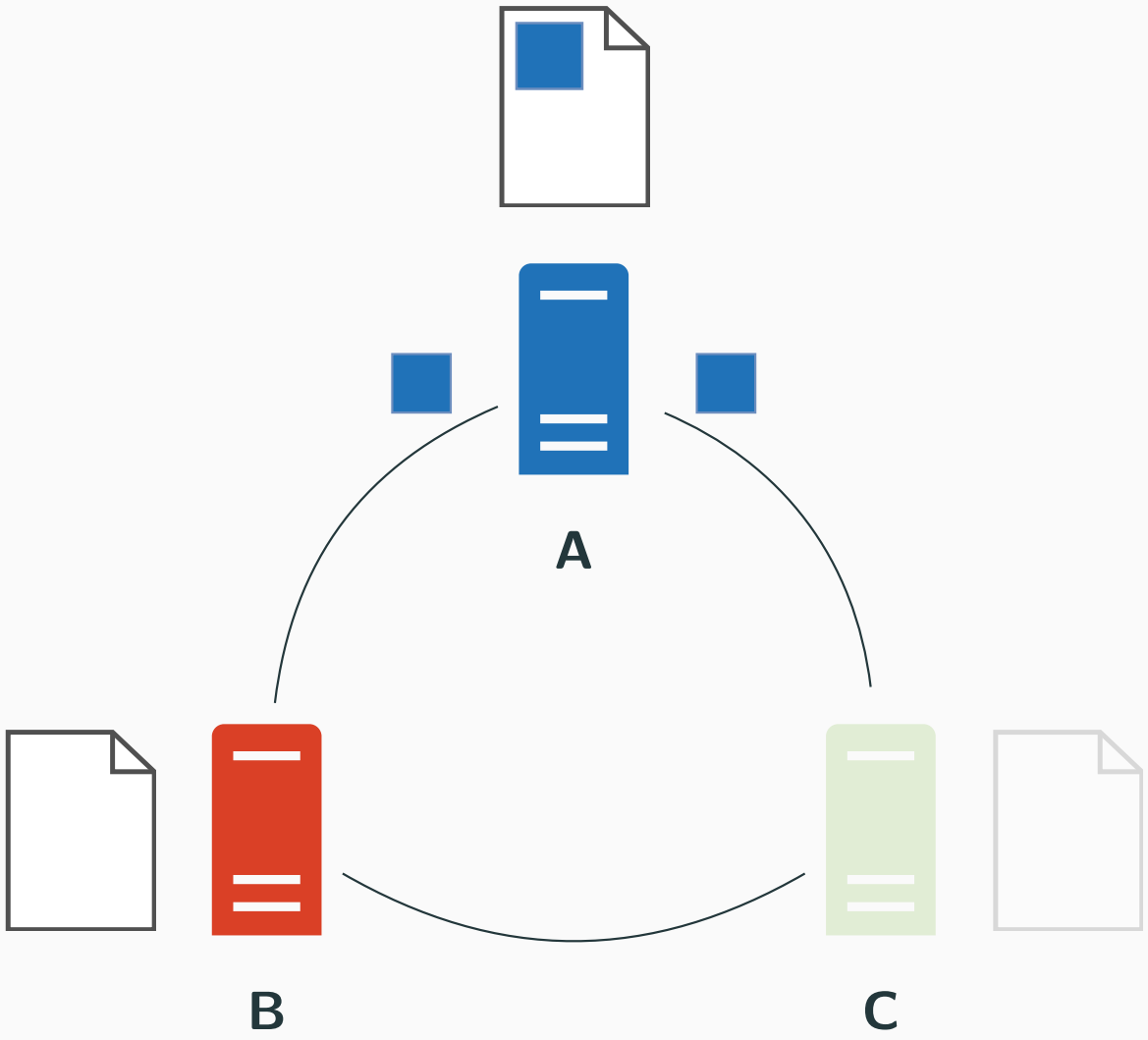

- Replicated data structure
- Updates performed without coordination

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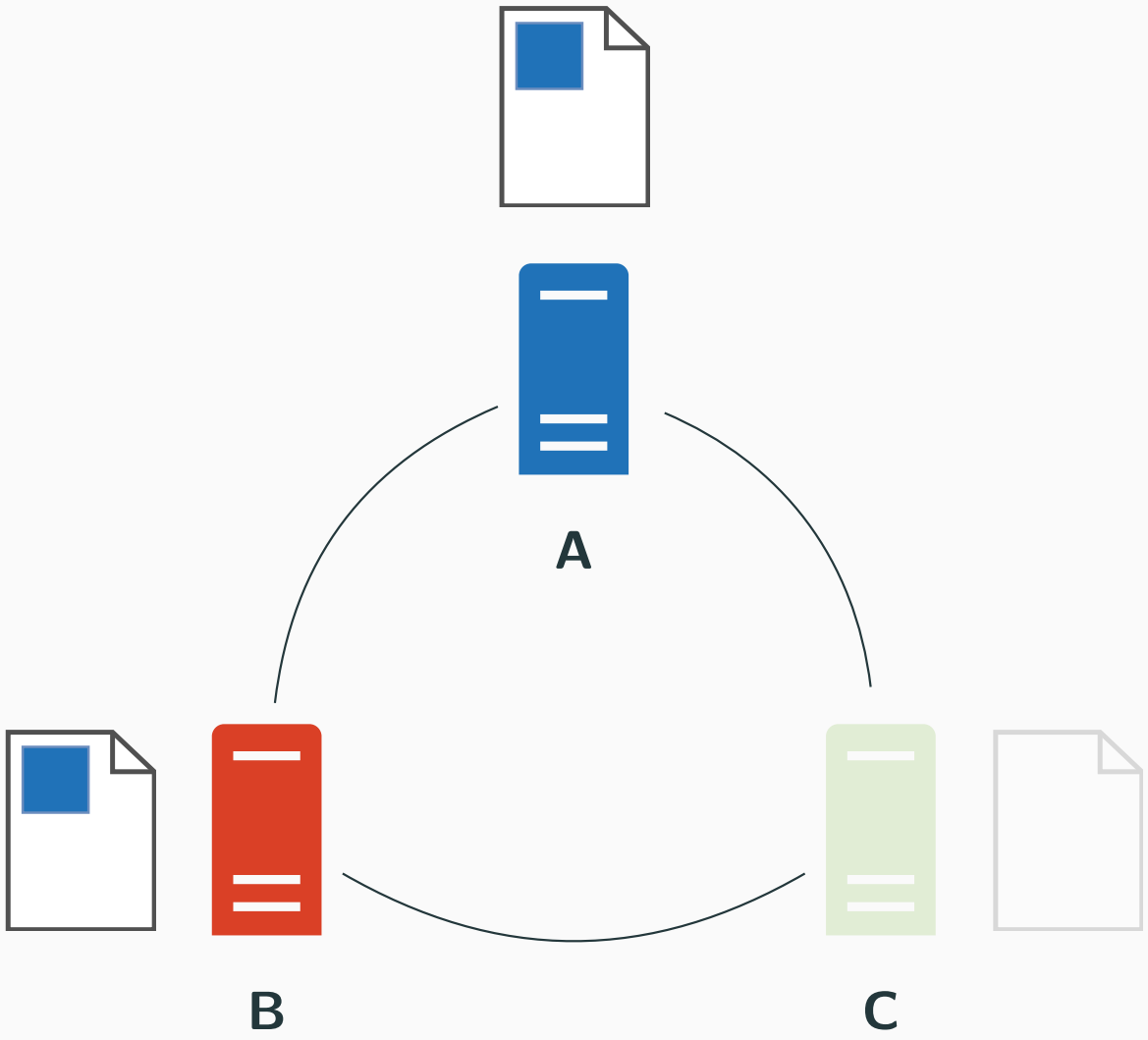

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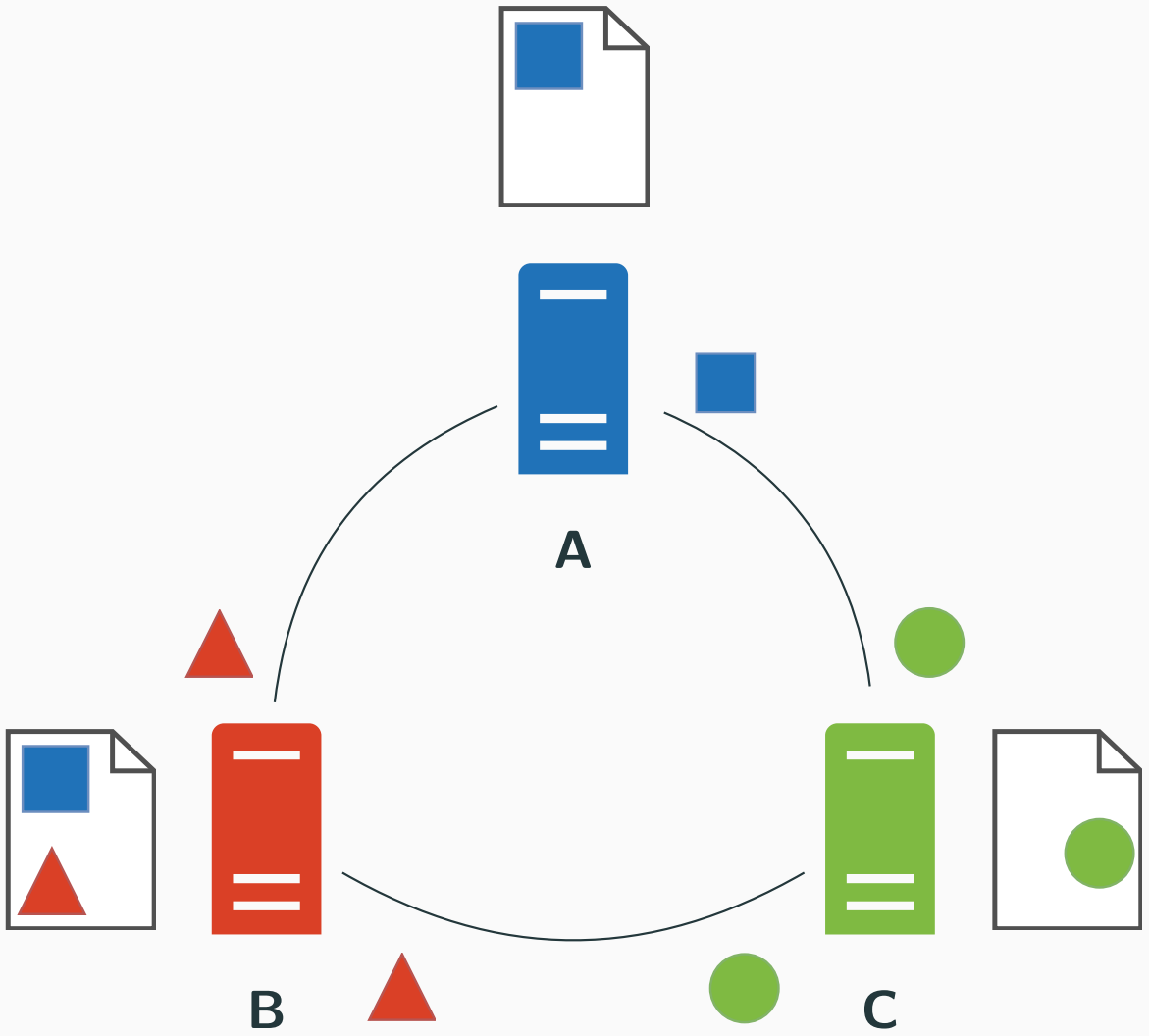

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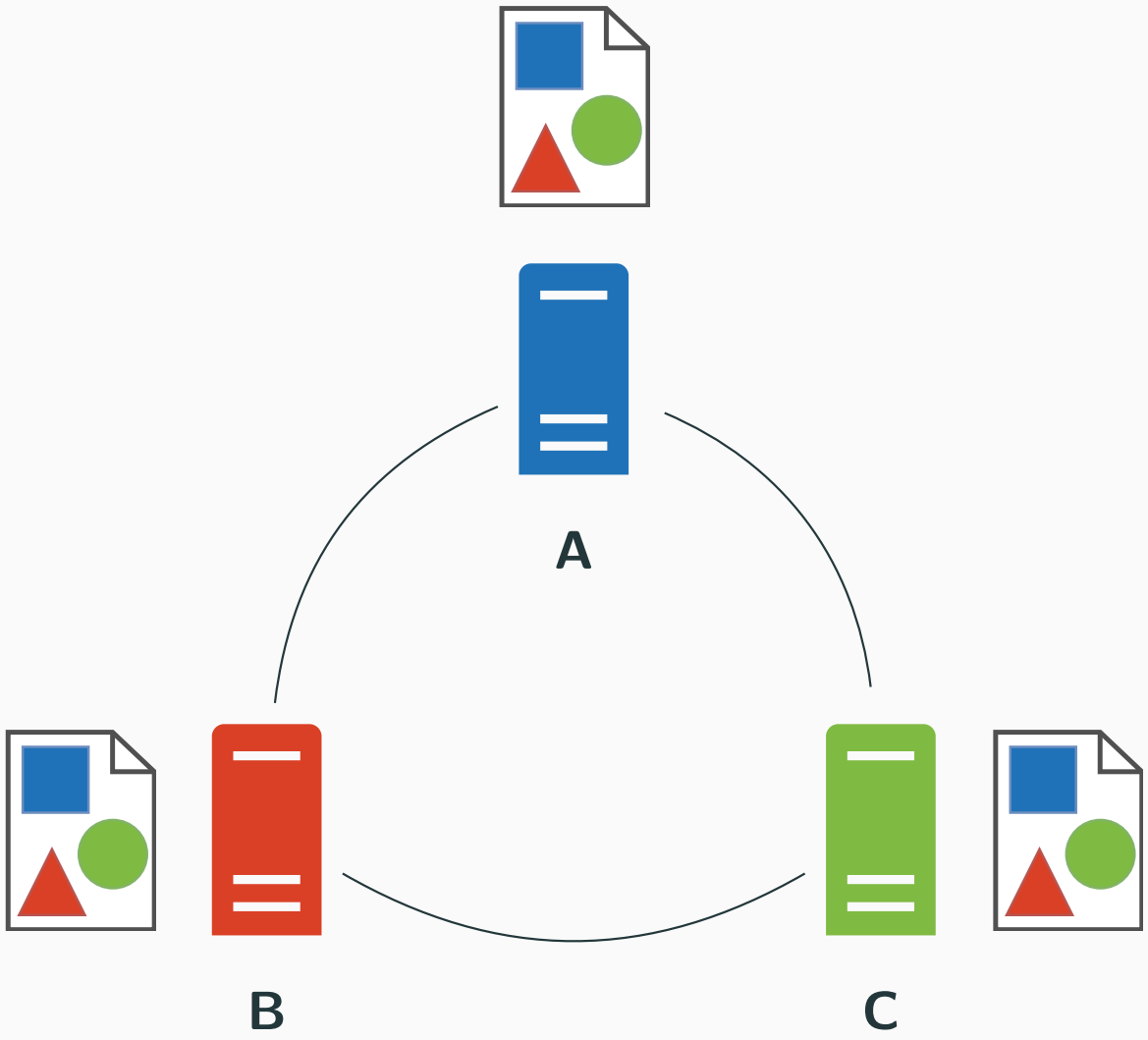

- Replicated data structure
- Updates performed without coordination
- Strong Eventual Consistency [3]

Identifier-based CRDTs

Main idea

- Attach an identifier to each element

Allow to design commutative updates

- Identifying uniquely elements
- Ordering updates causally
- ...

Research issue

Limits

- Unbounded size of identifiers
- Overhead of the data structure increasing over time

How to reduce the overhead introduced by the data structure ?

Proposition

- Reassign shorter identifiers in a fully distributed manner
- Focus on one CRDT

LogootSplit [1]

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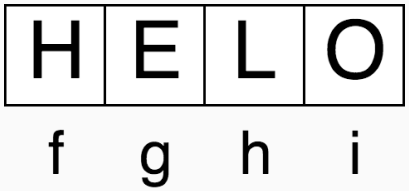

Figure 1: State of a sequence which contains the elements "helo" and their corresponding identifiers

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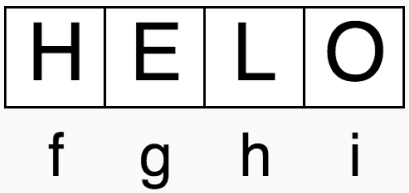

Figure 1: State of a sequence which contains the elements "helo" and their corresponding identifiers

Figure 2: State of a sequence which contains the block "helo"

Example

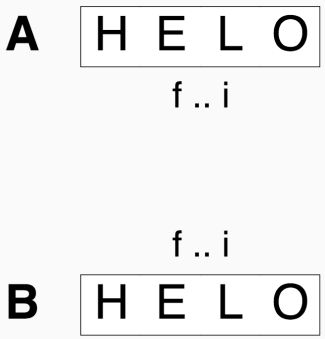

Figure 3: Example of concurrent *insert* operations

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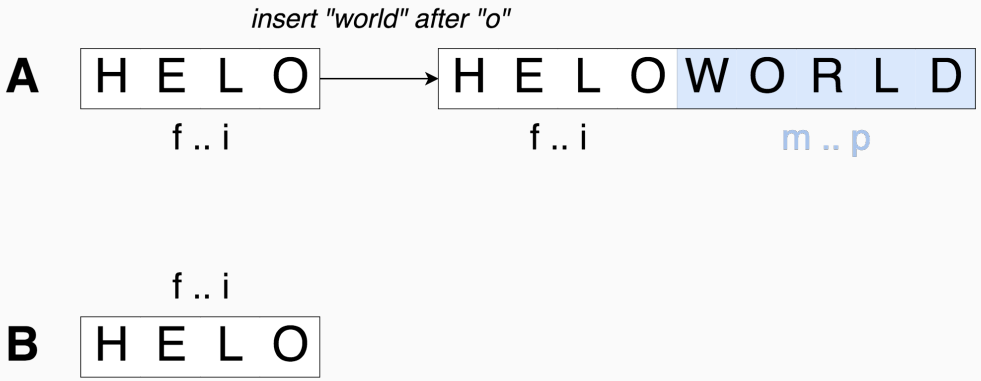

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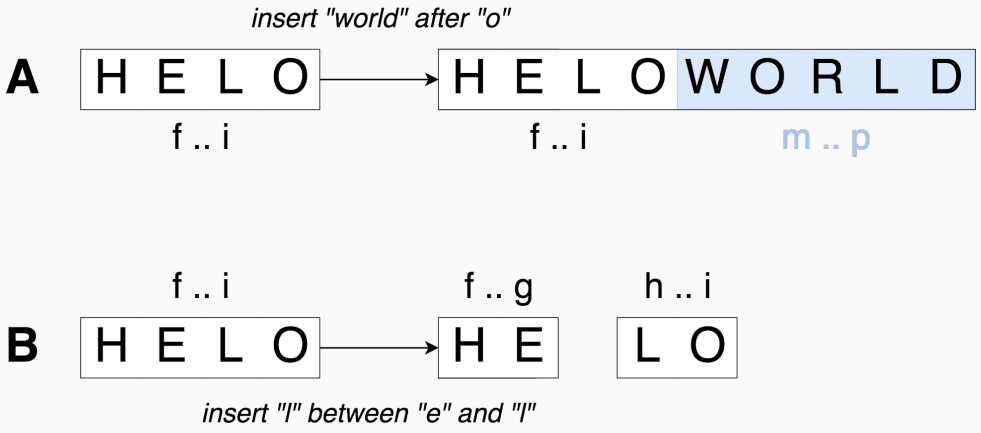

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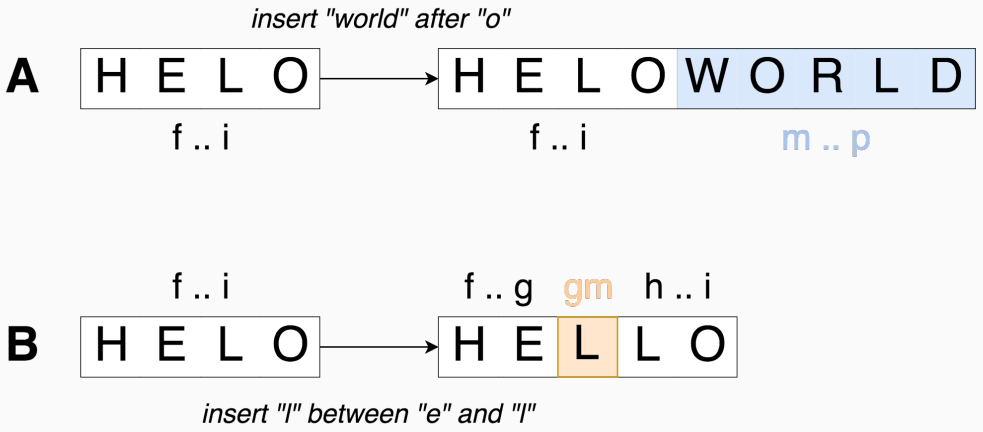

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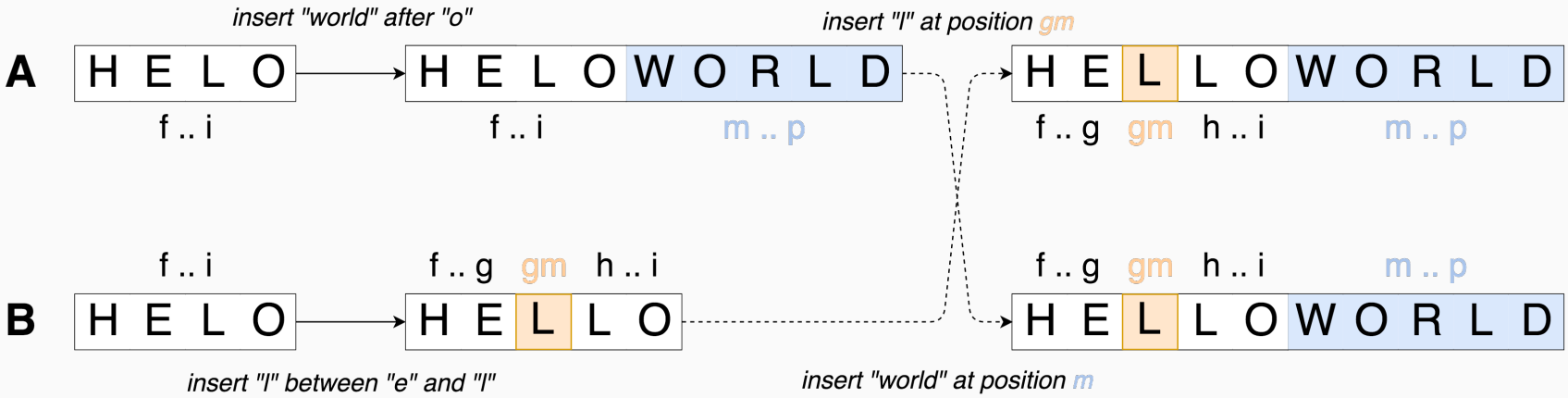

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Declining performances

- Updates performed may lead to an inefficient internal representation

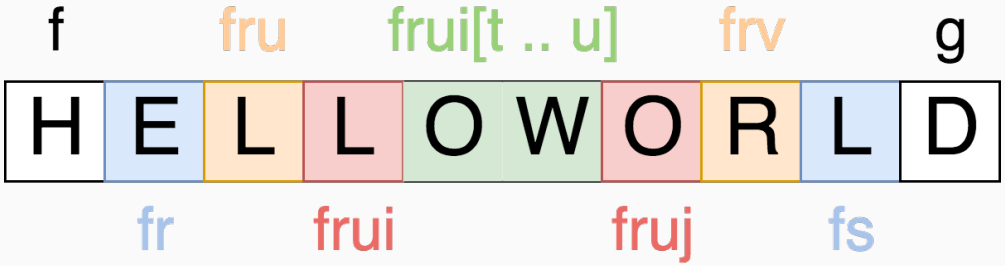
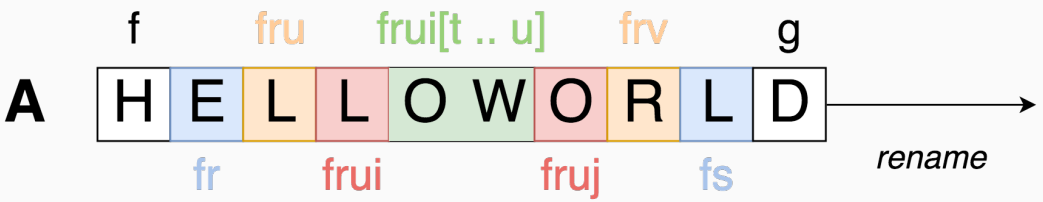


Figure 4: Example of inefficient internal representation

- The more blocks we have:
  - The more metadata we store
  - The longer it takes to browse the sequence to *insert* or *delete* an element

Renaming mechanism

- Introduce a *rename* operation



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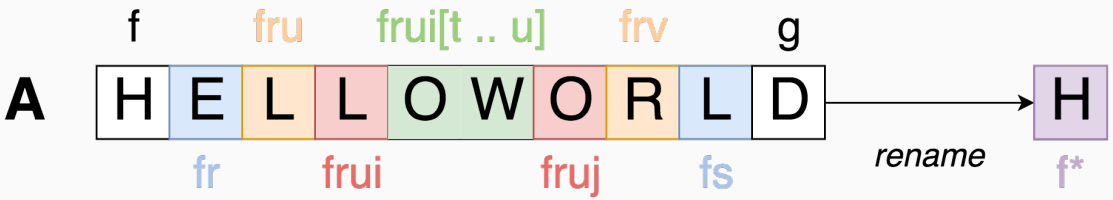

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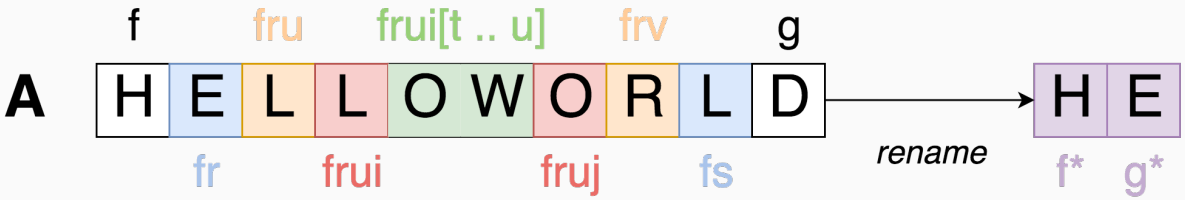

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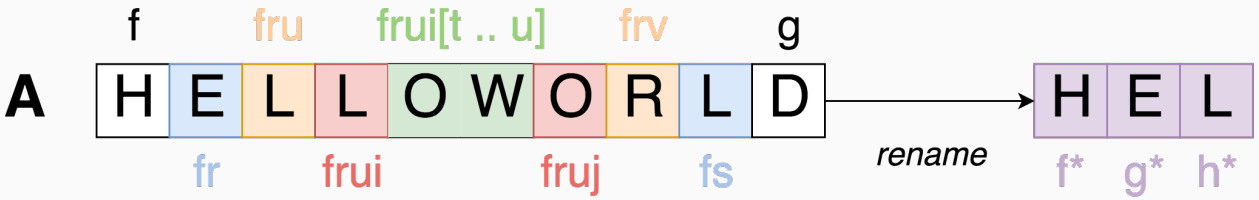

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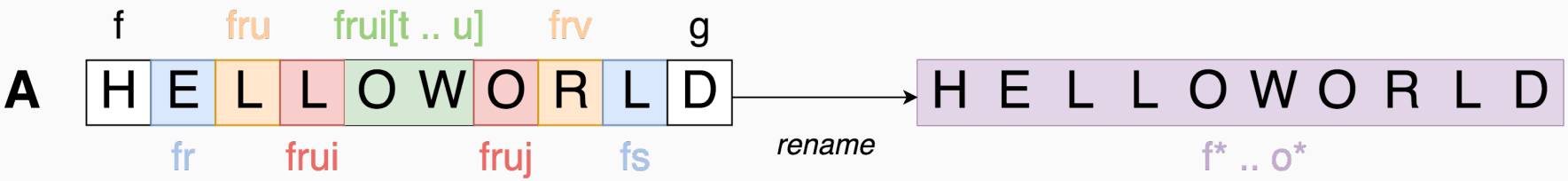

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Handling concurrent operations

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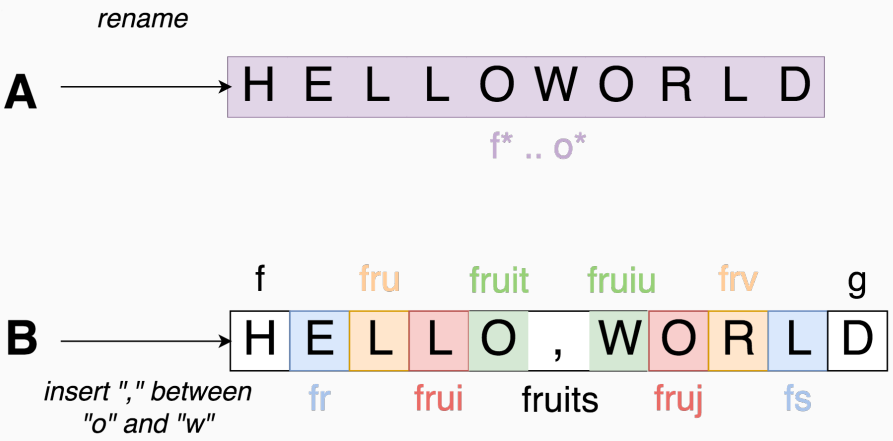

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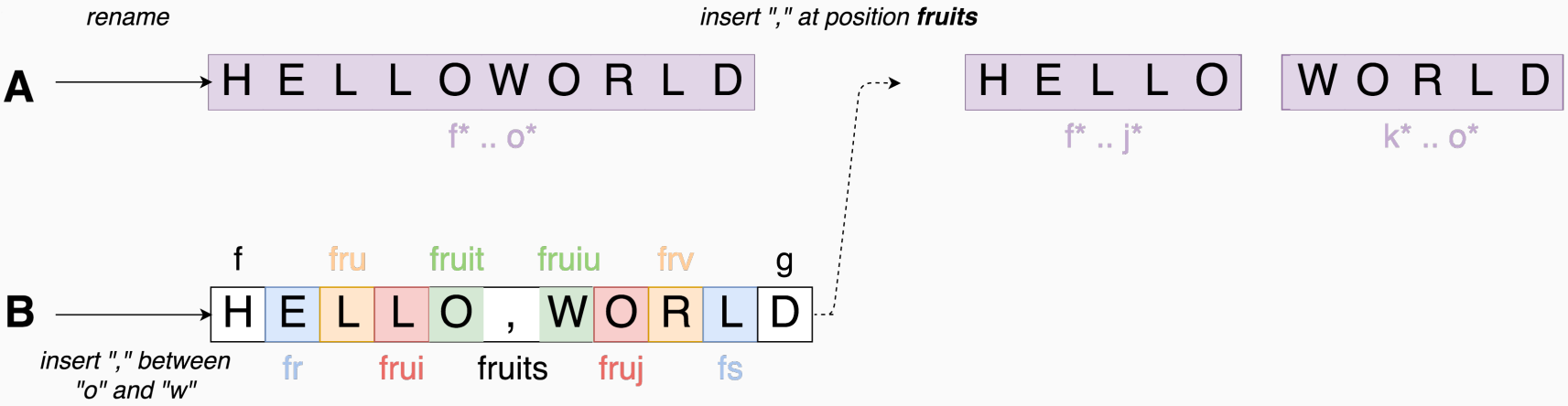

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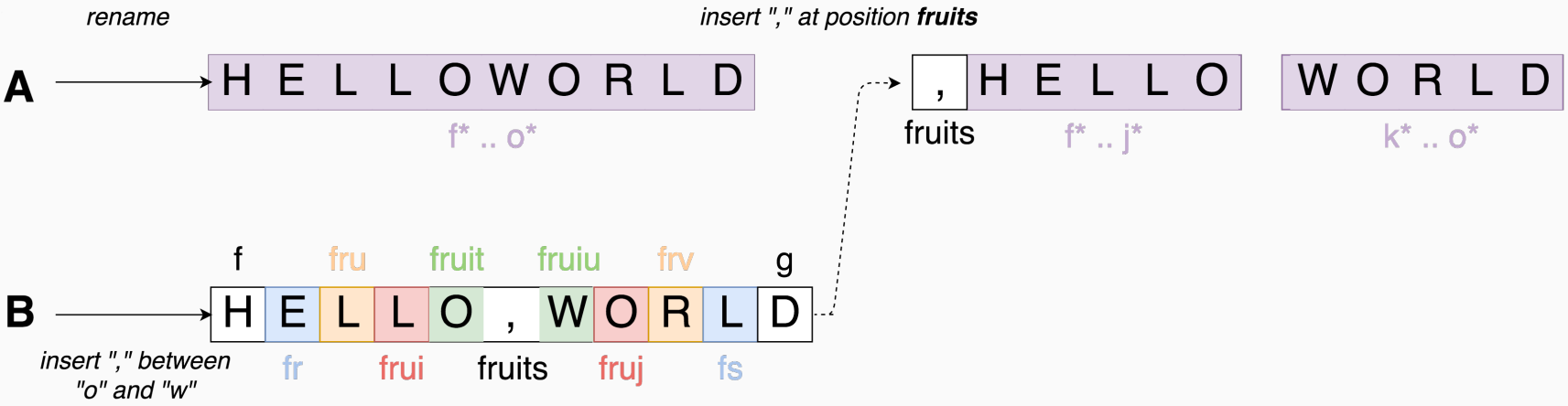

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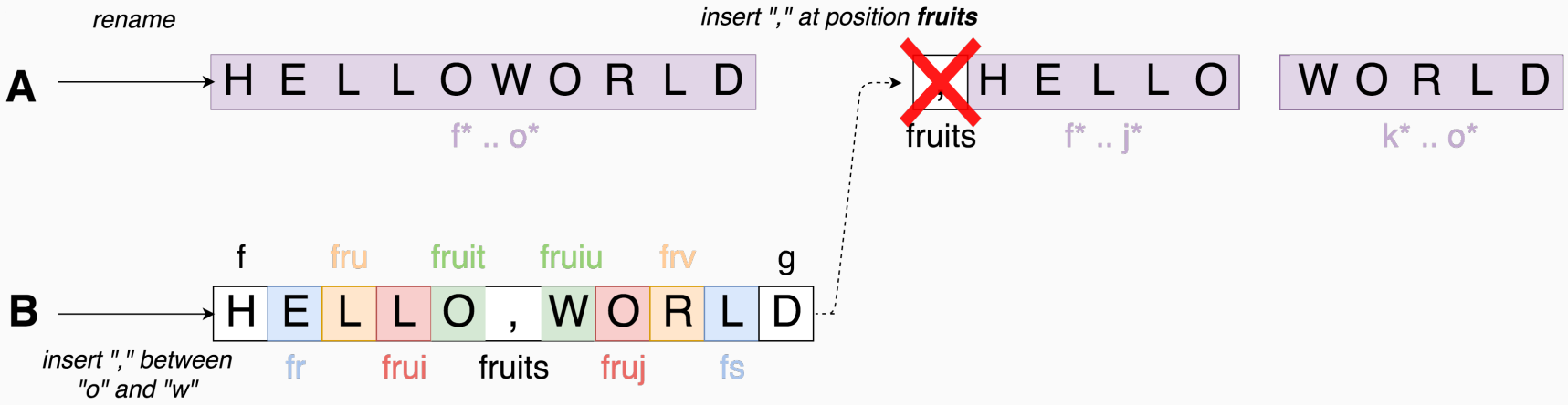

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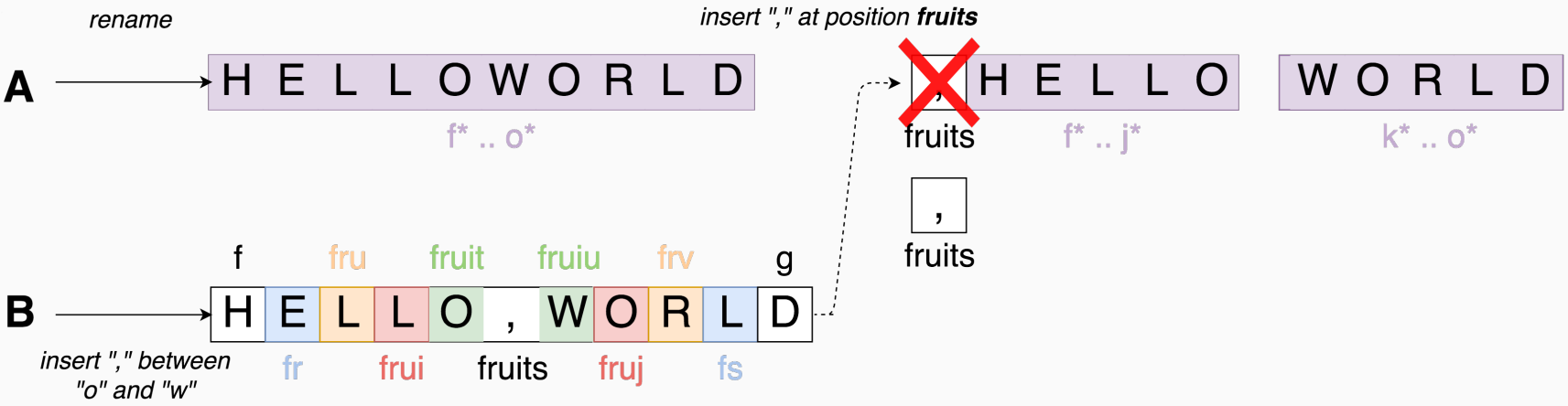

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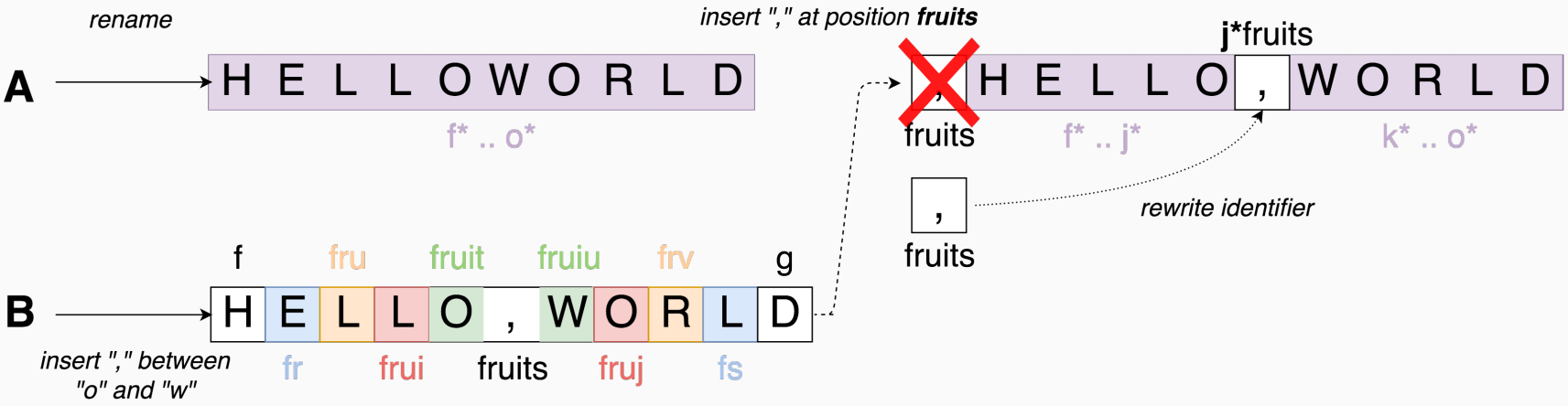

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Handling concurrent rename

- Define a total order between *rename* operations
- Pick a "winner" operation between concurrent *renames*
- Define additional rewriting rules to *undo* the effect of "losing" ones

To wrap up

Done

- Designed a *rename* operation for LogootSplit
- Defined rewriting rules to deal with concurrent updates

Work in progress

- Implementation in MUTE [2], our P2P collaborative text editor
- Design the strategy to trigger the renaming

To do

- Prove formally the correctness of the mechanism
- Benchmark its performances

Next steps

Generalize the approach

- To other Sequence CRDTs
- To other types
  - Counter
  - Set
  - ...

Thanks for your attention, any questions?

References i

[1] L. André, S. Martin, G. Oster, and C.-L. Ignat.
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[2] M. Nicolas, V. Elvinger, G. Oster, C.-L. Ignat, and F. Charoy.
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References ii

[3] M. Shapiro, N. M. Preguiça, C. Baquero, and M. Zawirski.
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