Relaxing the Consistency Condition

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Local Linearizability (CONCUR16)

Local Linearizability main idea

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- Partition a history into a set of local histories
- Require linearizability per local history

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Already present in some shared-memory consistency conditions
(not in our form of choice)

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Local sequential consistency… is also possible

Local Linearizability main idea

Already present in some shared-memory consistency conditions
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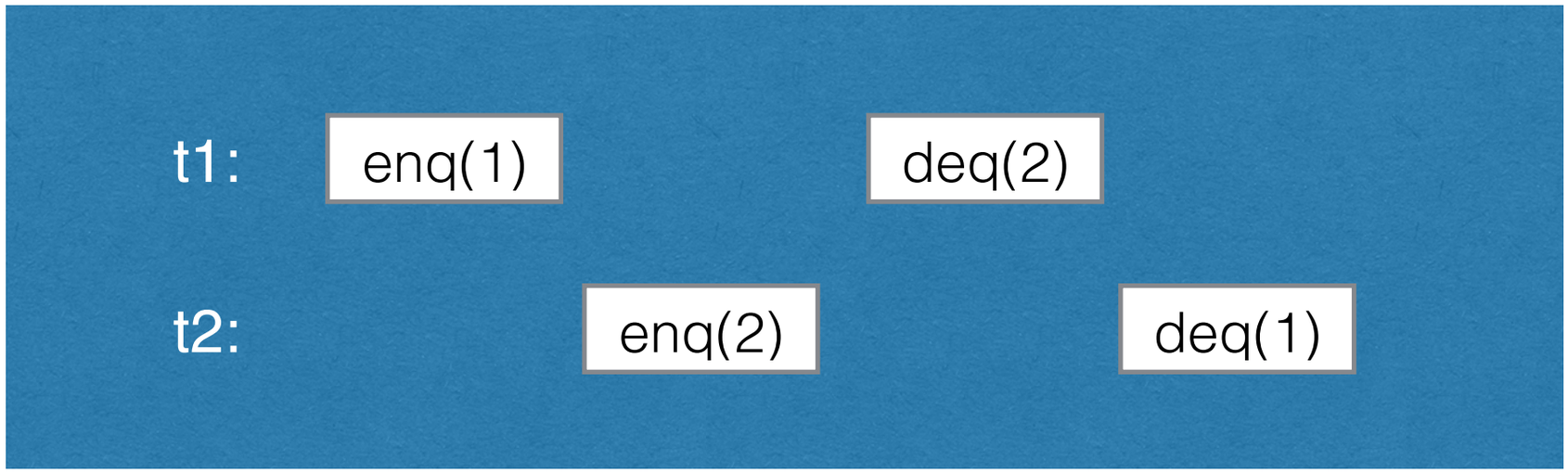
- Partition a history into a set of local histories

- Require linearizability per local history

no global witness

Local sequential consistency… is also possible

Local Linearizability (queue) example



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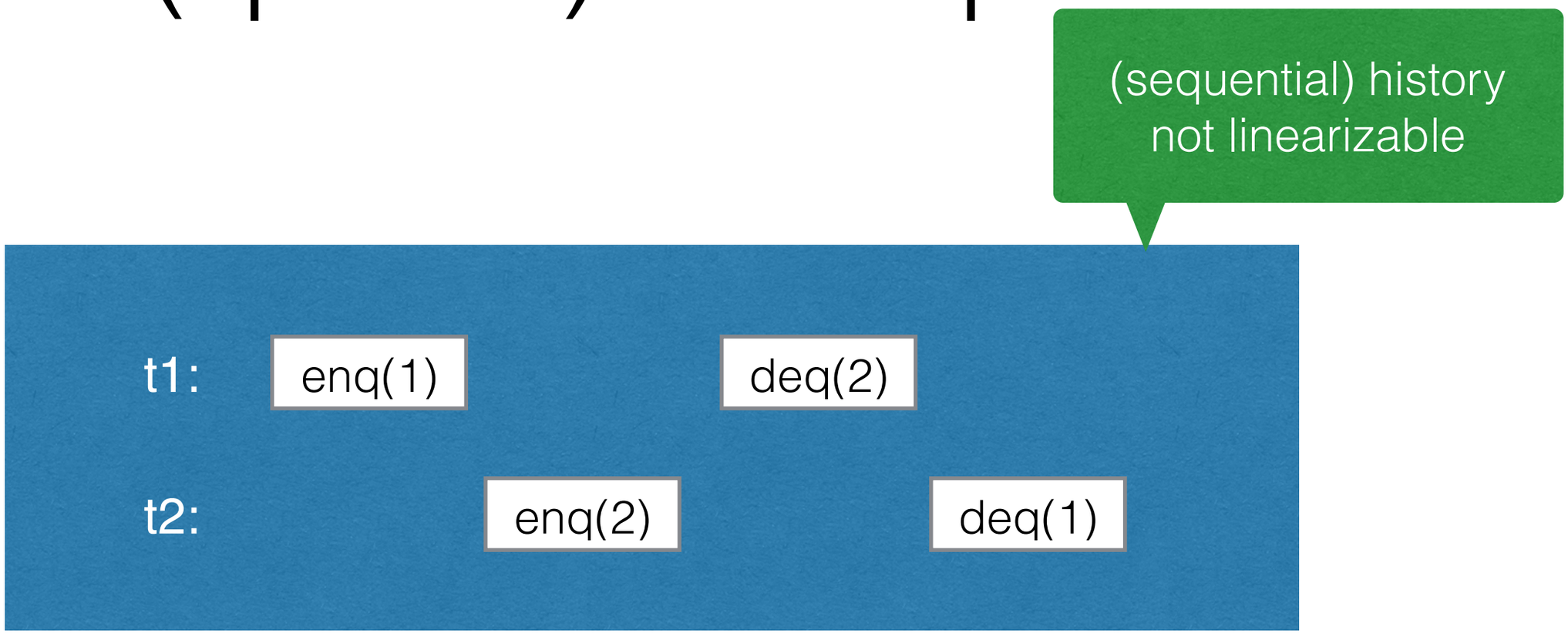

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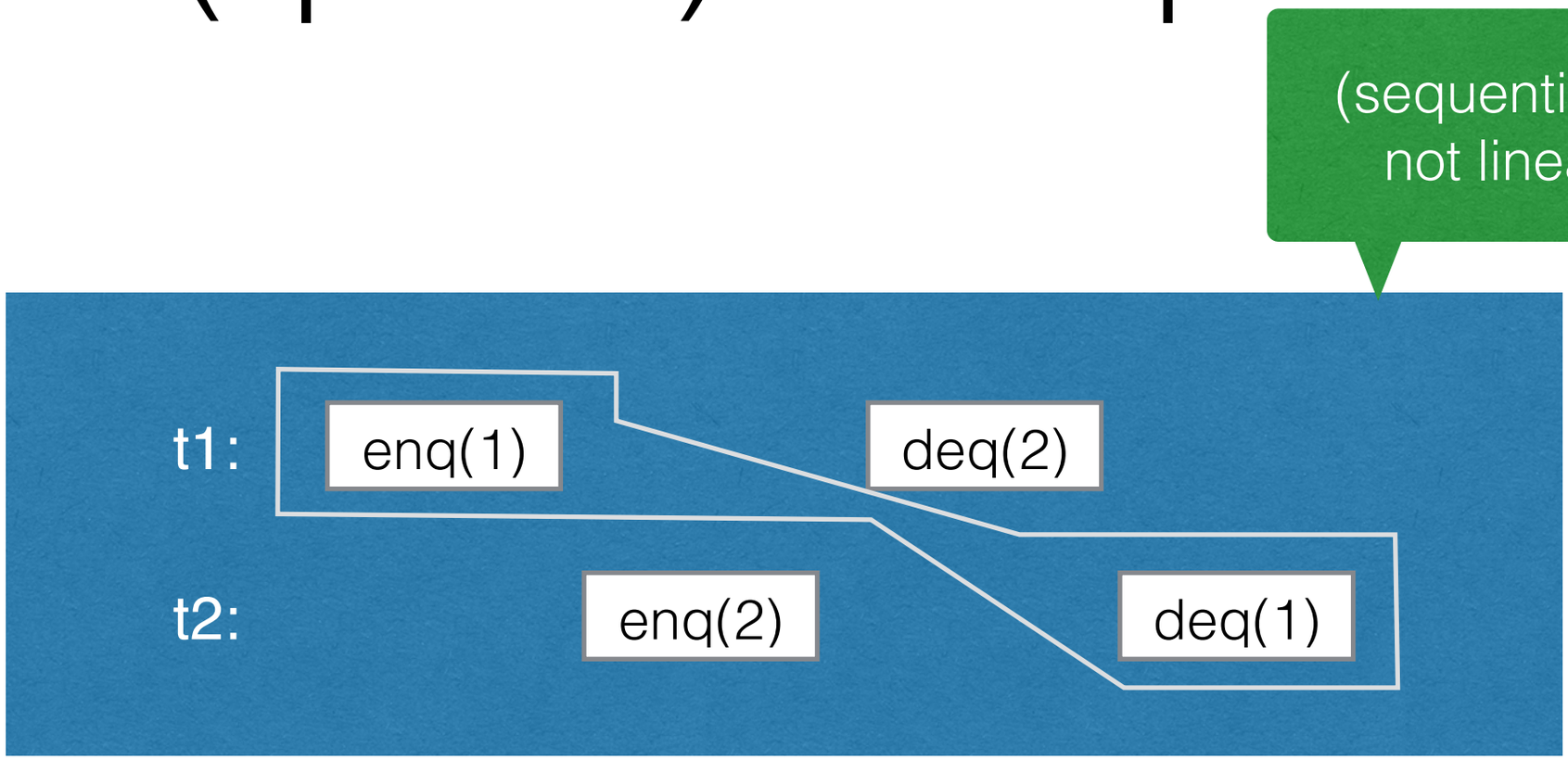

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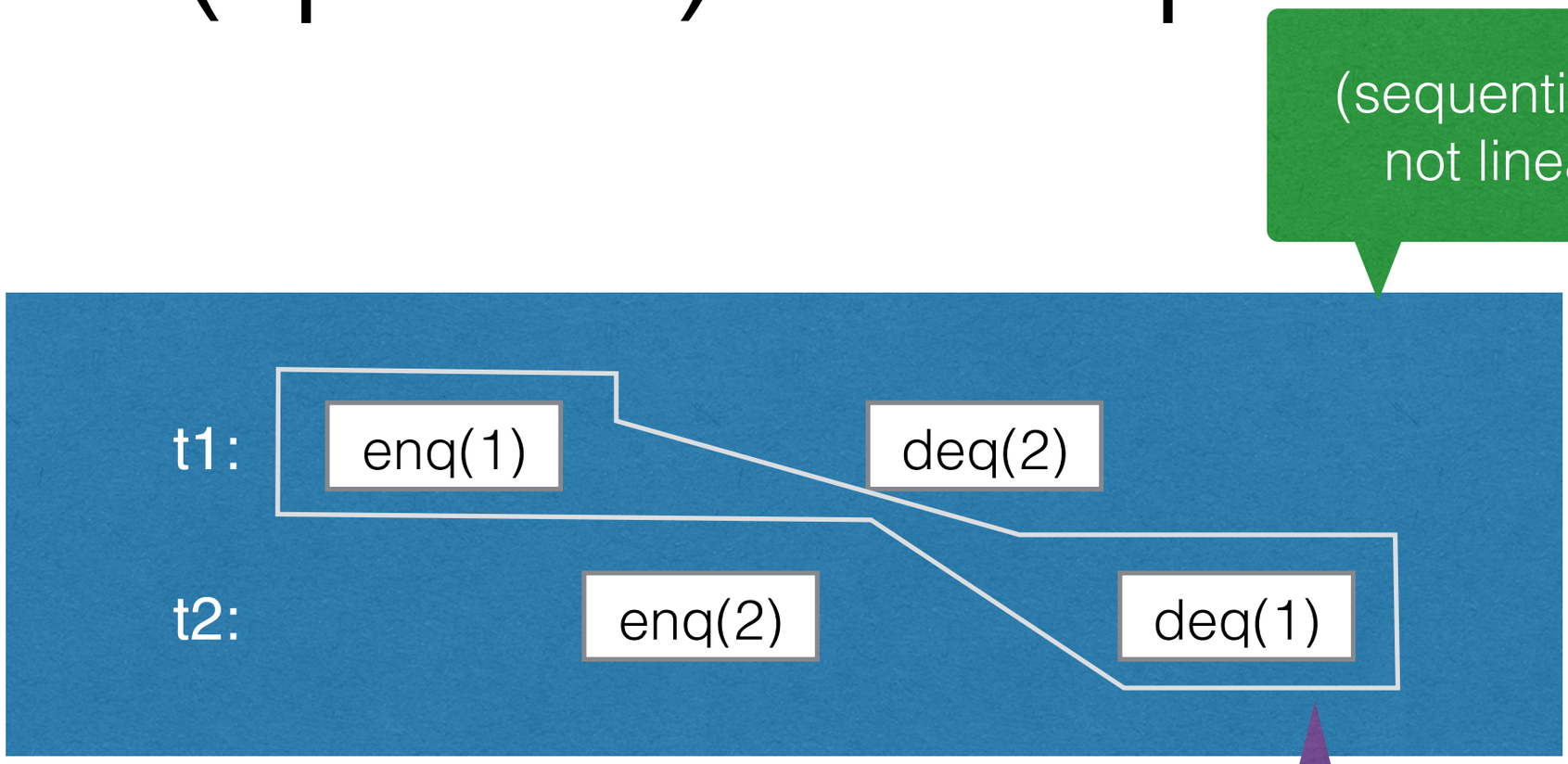

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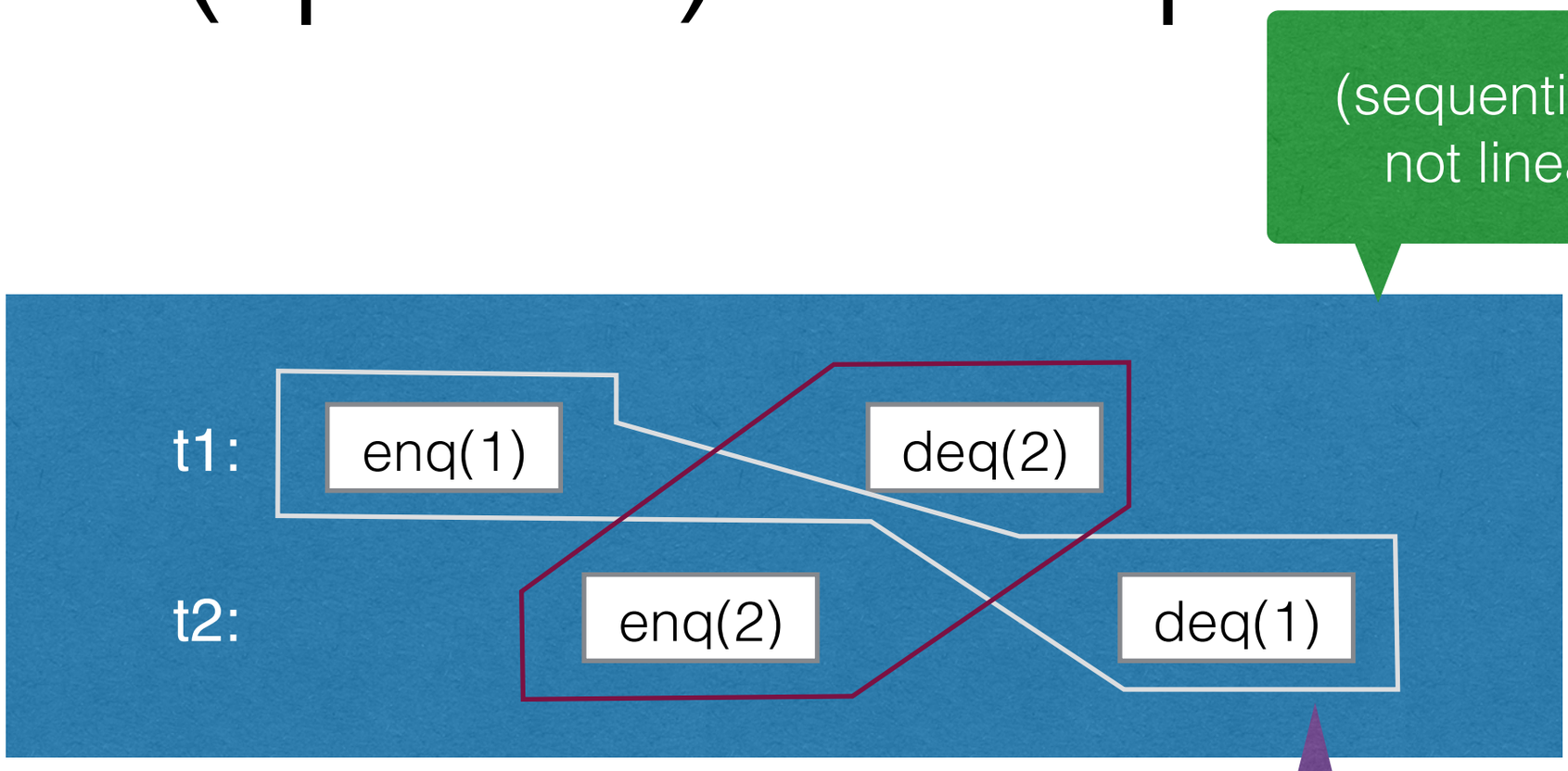

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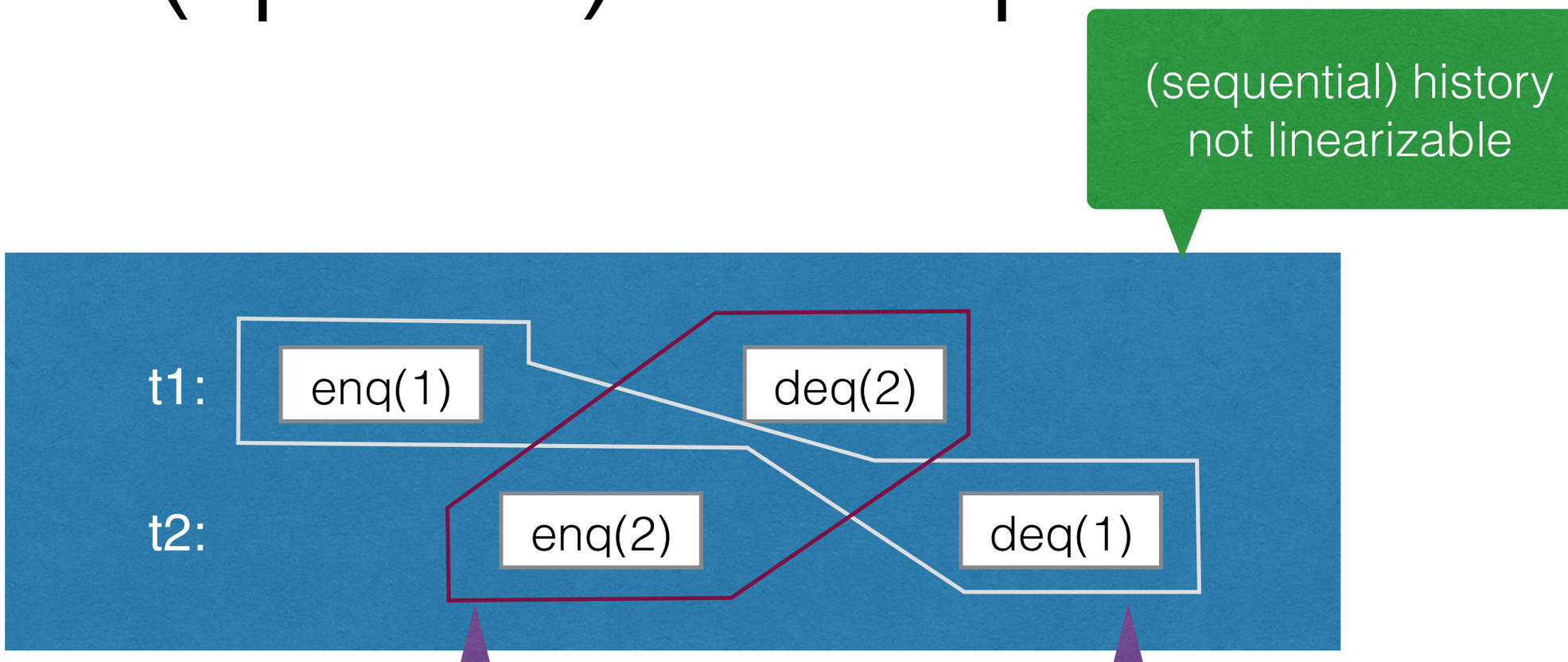

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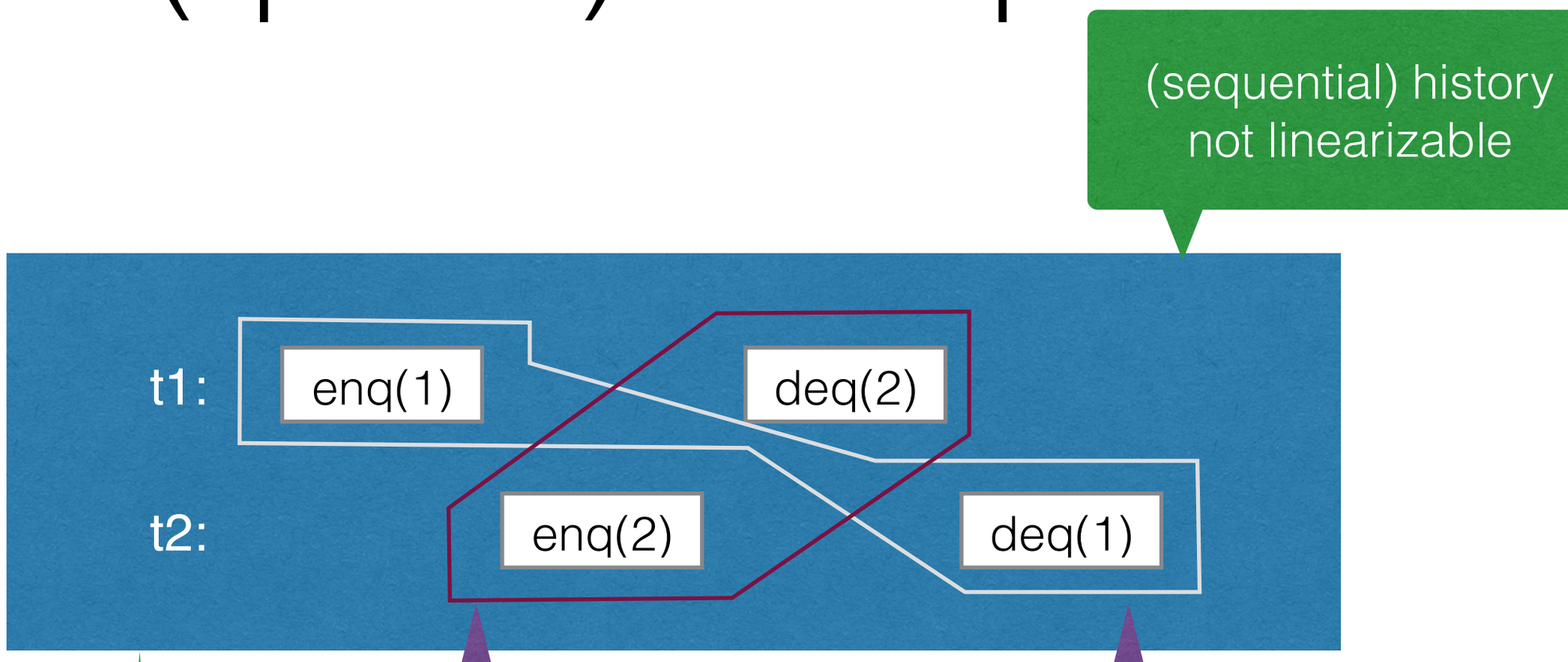

Local Linearizability (queue) definition

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Queue signature $\Sigma = \{enq(x) \mid x \in V\} \cup \{deq(x) \mid x \in V\} \cup \{deq(empty)\}$

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For a history **h** with a thread T, we put

$$I_T = \{enq(x)^T \in \mathbf{h} \mid x \in V\}$$

$$O_T = \{deq(x)^{T'} \in \mathbf{h} \mid enq(x)^T \in I_T\} \cup \{deq(empty)\}$$

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h is locally linearizable iff every thread-induced history

$\mathbf{h}_T = \mathbf{h} \mid (I_T \cup O_T)$

is linearizable.

Local Linearizability for Container-Type DS

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Signature $\sum$ = Ins ∪ Rem ∪ SOb ∪ DOb

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$$I_T = \{m^T \in \mathbf{h} \mid m \in Ins\}$$

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out-methods of thread T are removes and data-observations (performed by any thread) corresponding to in-methods

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Generalizations of Local Linearizability

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Signature Σ

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For a history **h** with n threads, choose

$In_{\mathbf{h}}(i)$

$Out_{\mathbf{h}}(i)$

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Generalizations of Local Linearizability

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For a history **h** with n threads, choose

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$Out_{\mathbf{h}}(i)$

in-methods of thread i, methods that go in $\mathbf{h}_i$

by increasing the in-methods, LL gradually moves to linearizability

out-methods of thread i, dependent methods on the methods in $In_{\mathbf{h}}(i)$ (performed by any thread)

h is locally linearizable iff every thread-induced history

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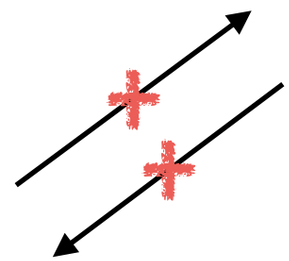
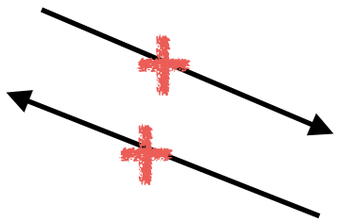
Where do we stand?

In general

Linearizability



Local Linearizability



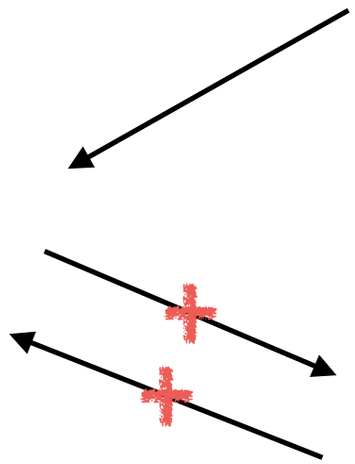
Sequential Consistency

Where do we stand?

For queues (and most container-type data structures)

Linearizability

Local Linearizability



Sequential Consistency

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unlike sequential consistency

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h (over multiple objects) is locally linearizable
iff
each per-object subhistory of **h** is locally linearizable

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may allow for modular verification