



departamento de informática
FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE NOVA DE LISBOA

Concurrency and Parallelism (Concorrência e Paralelismo – CP 11158)

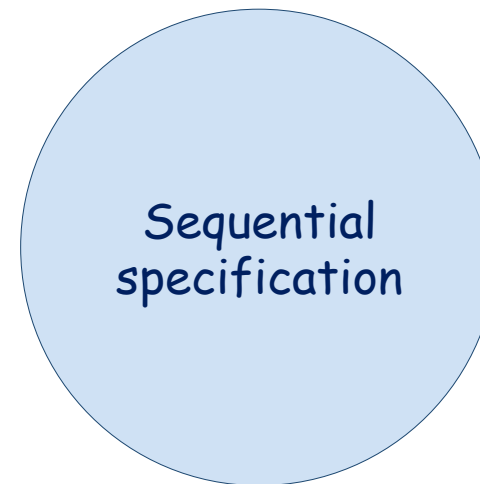
Lecture 4

— Linearizability and Serializability —

*Slides based in material from:
Gadi Taubenfeld (<http://www.faculty.idc.ac.il/gadi/book.htm>)*

Sequential Specification of an object

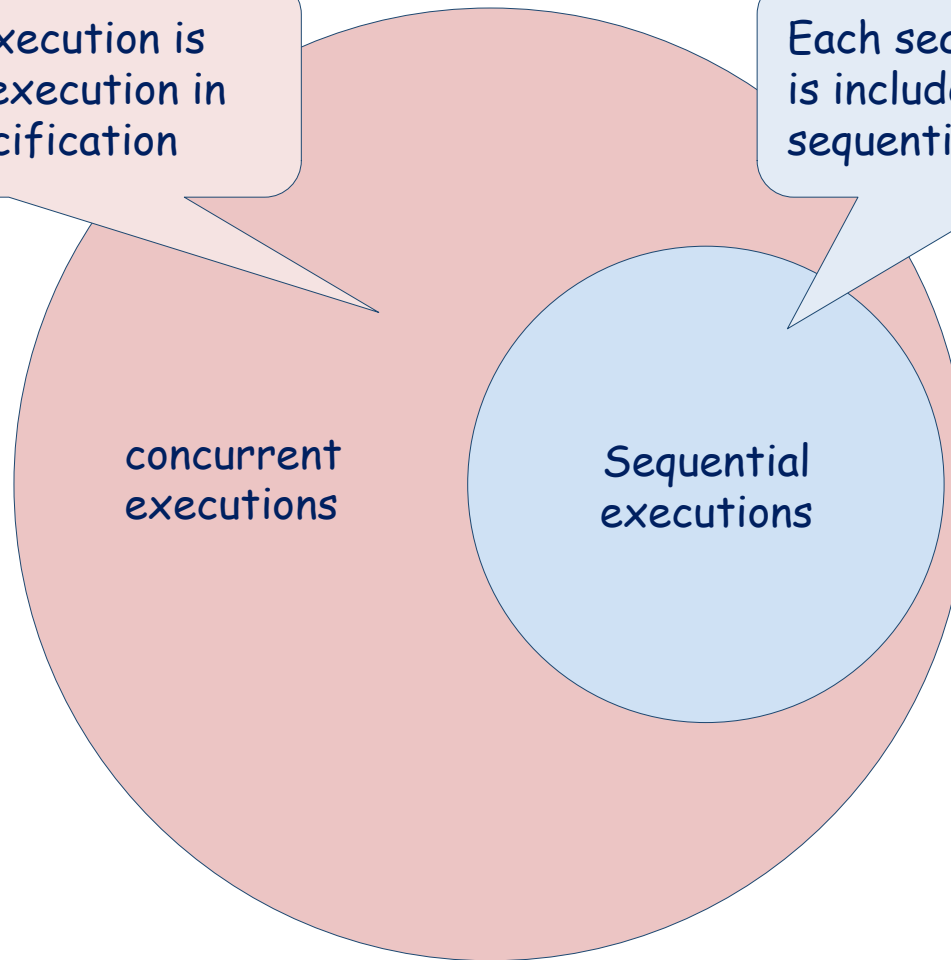
- **Queue:** In sequential executions, the enqueue operation inserts a value to the queue and the dequeue operation returns and deletes the oldest value in the queue.



Linearizability for an object

Each concurrent execution is
"equivalent" to an execution in
the sequential specification

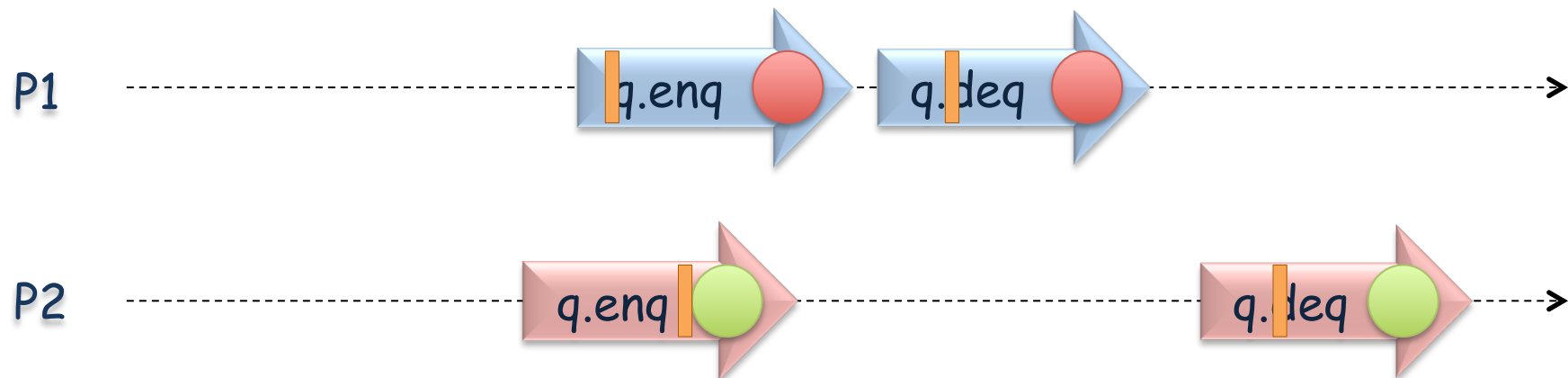
Each sequential execution
is included in the
sequential specification



All executions

Linearizability for an object

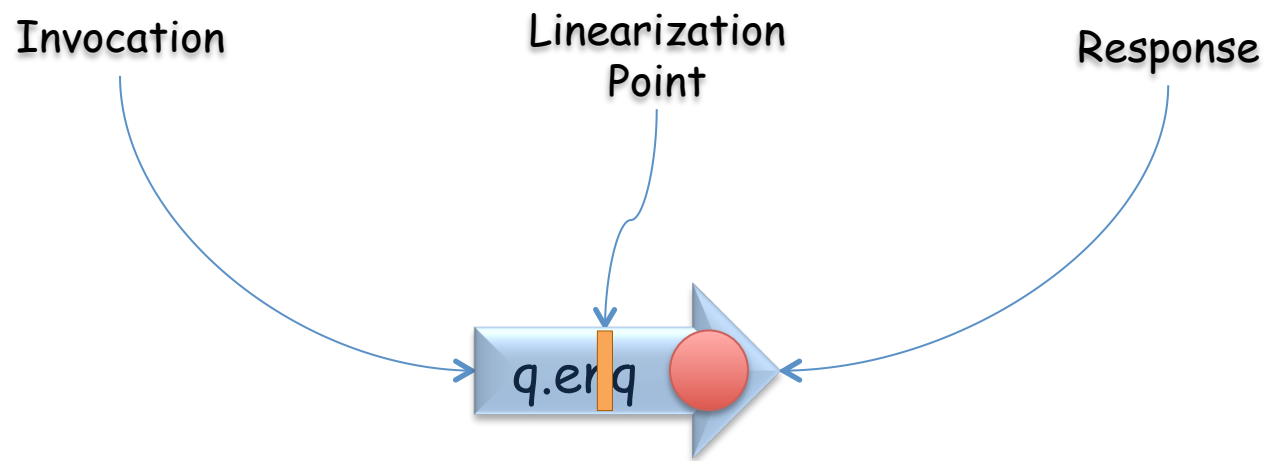
- Need to preserve real time order
- Each operation should appear to “take effect” instantaneously at some moment between its invocation and response
- Object is correct if this “sequential” behavior is correct



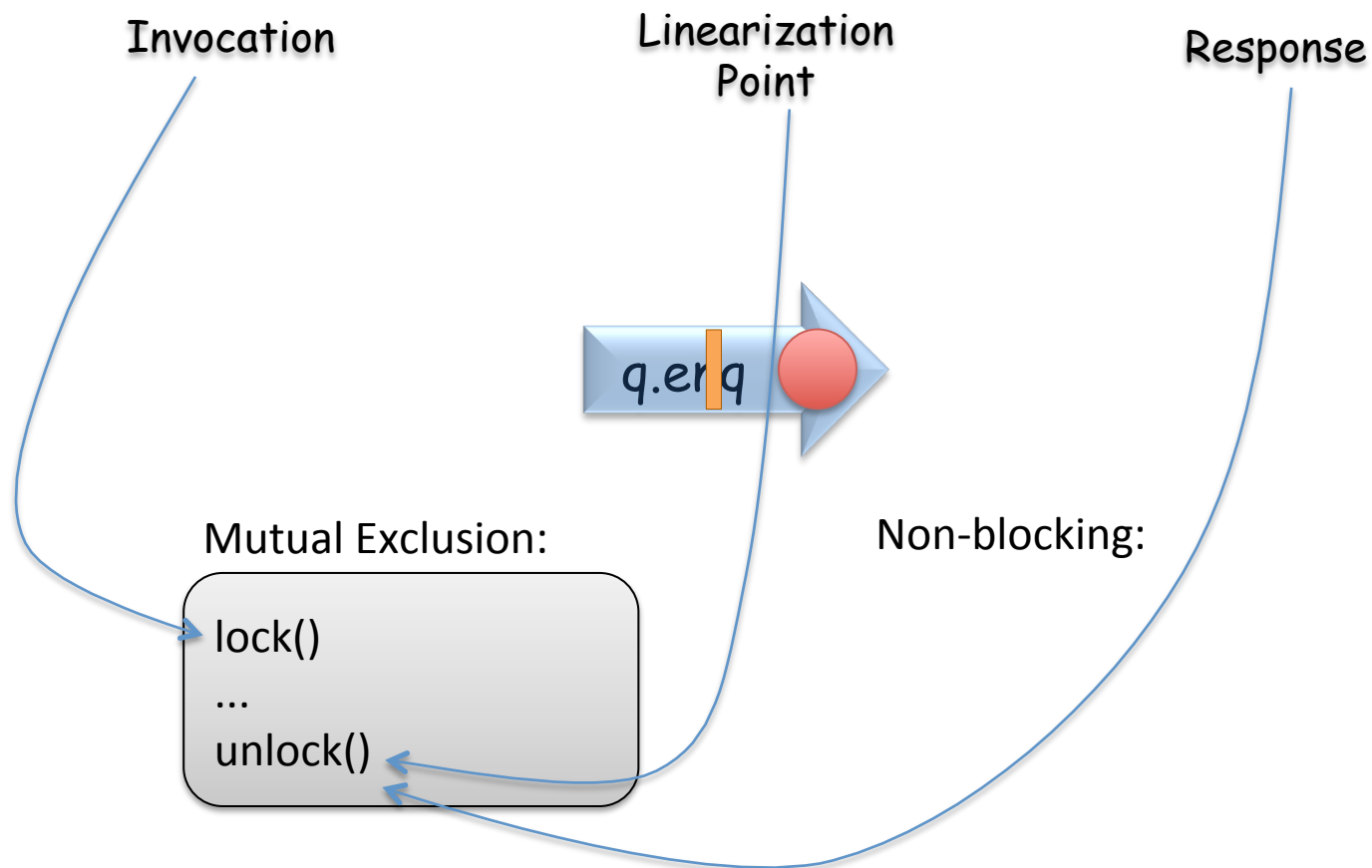
Linearizability

- Permits programmers to specify and reason about concurrent objects using known techniques from the sequential domain
- Provides the illusion that each operation applied by concurrent processes takes effect instantaneously between its invocation and its response

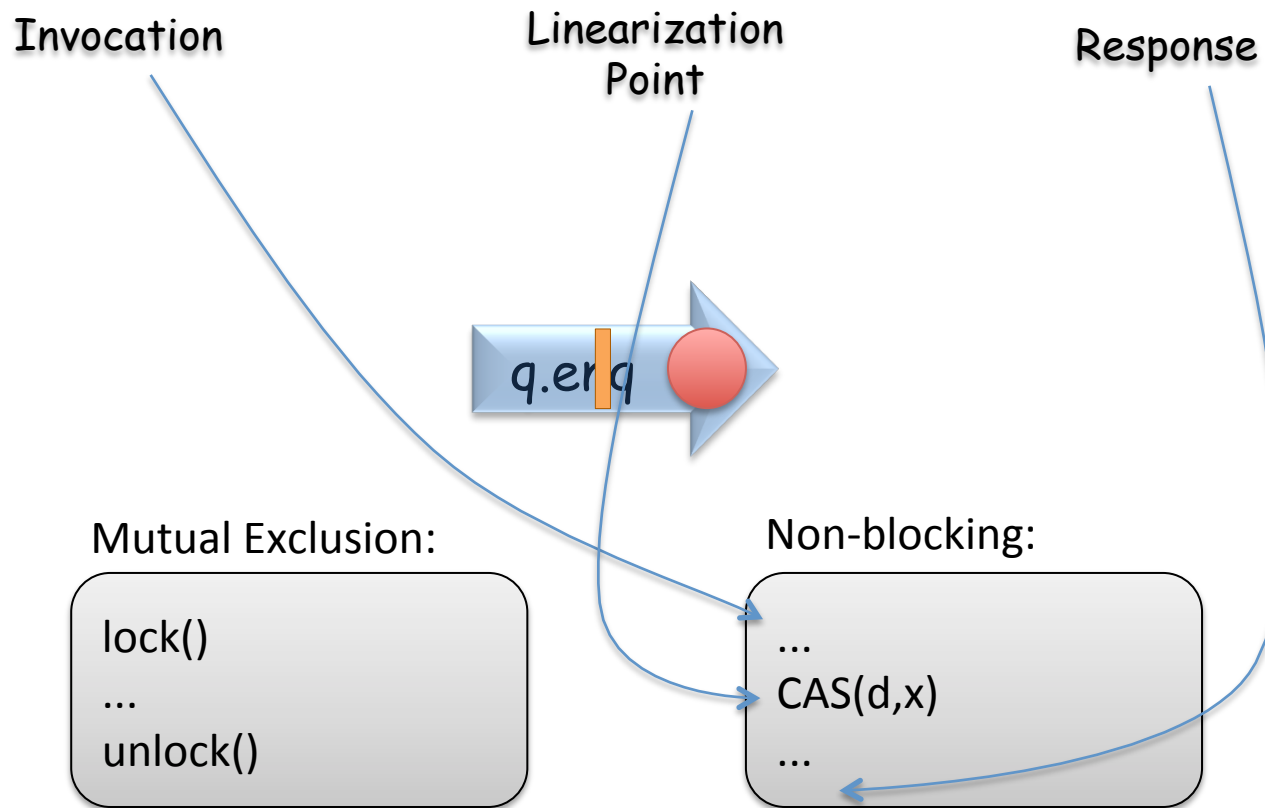
Terminology



Terminology

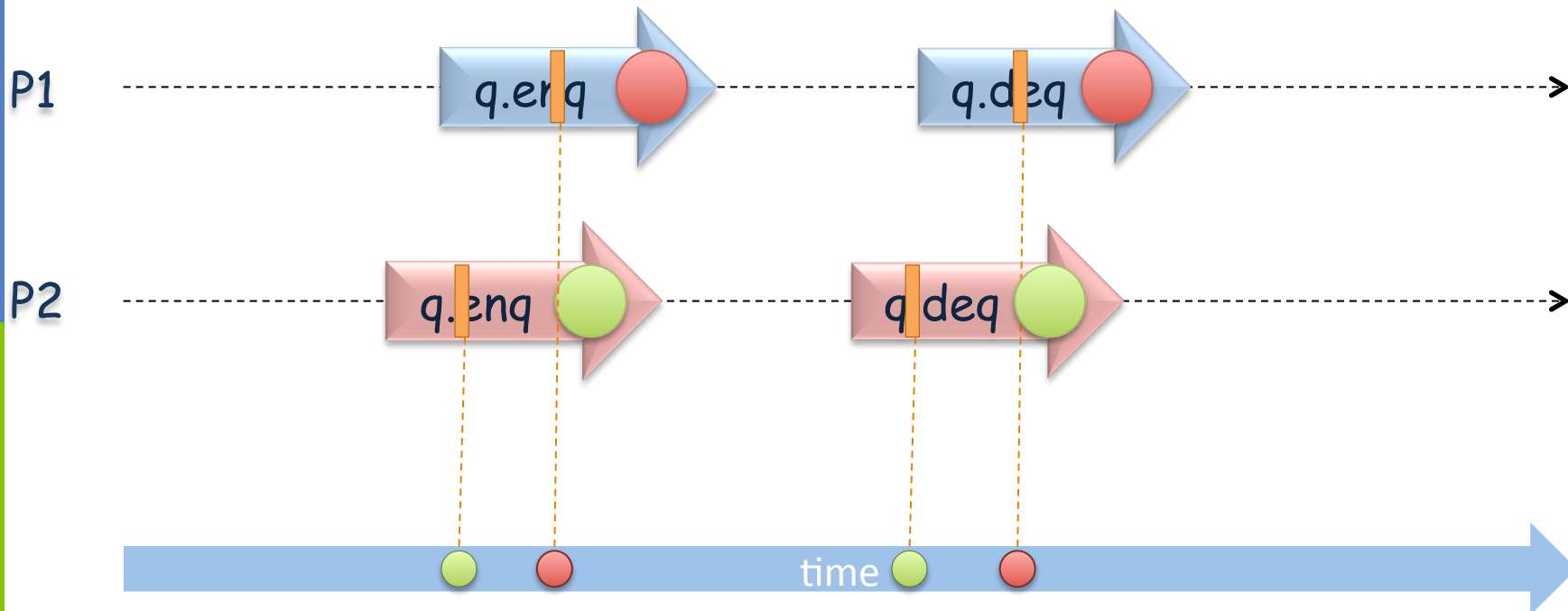


Terminology



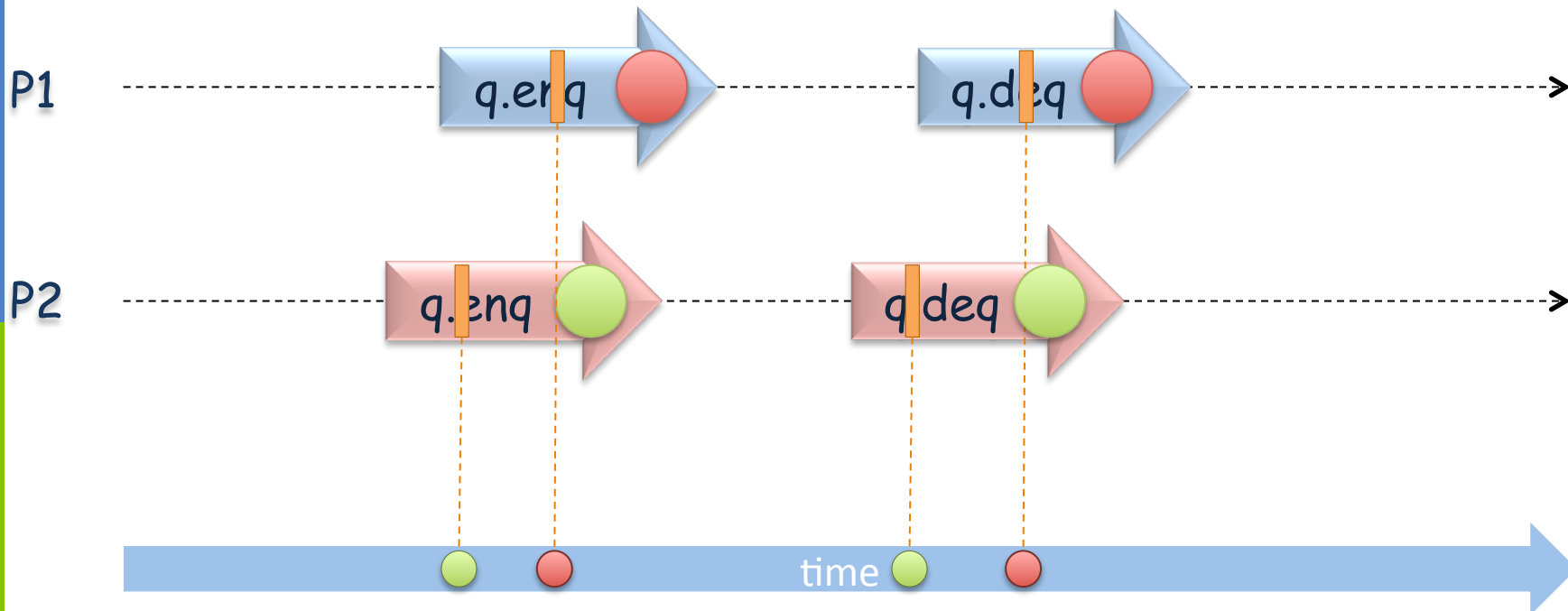
Linearizability

Is this execution linearizable? **Yes**



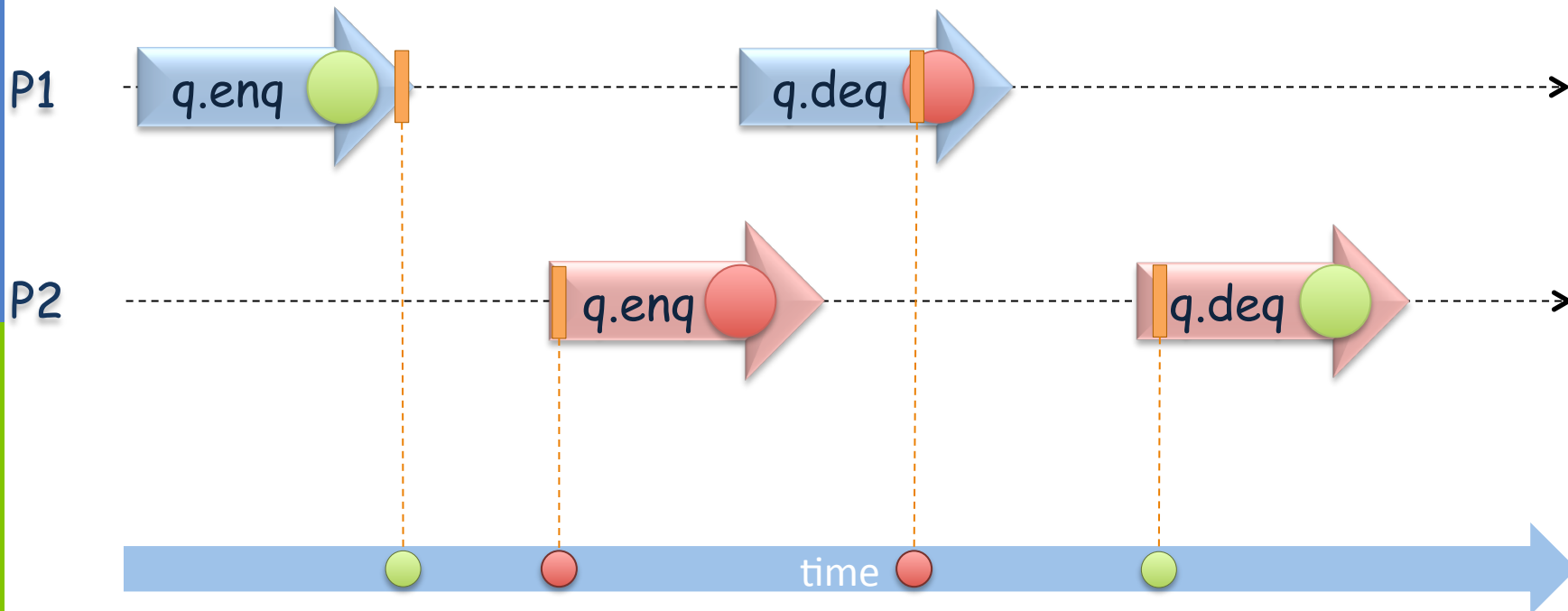
Linearizability

Is this execution linearizable? **Yes**



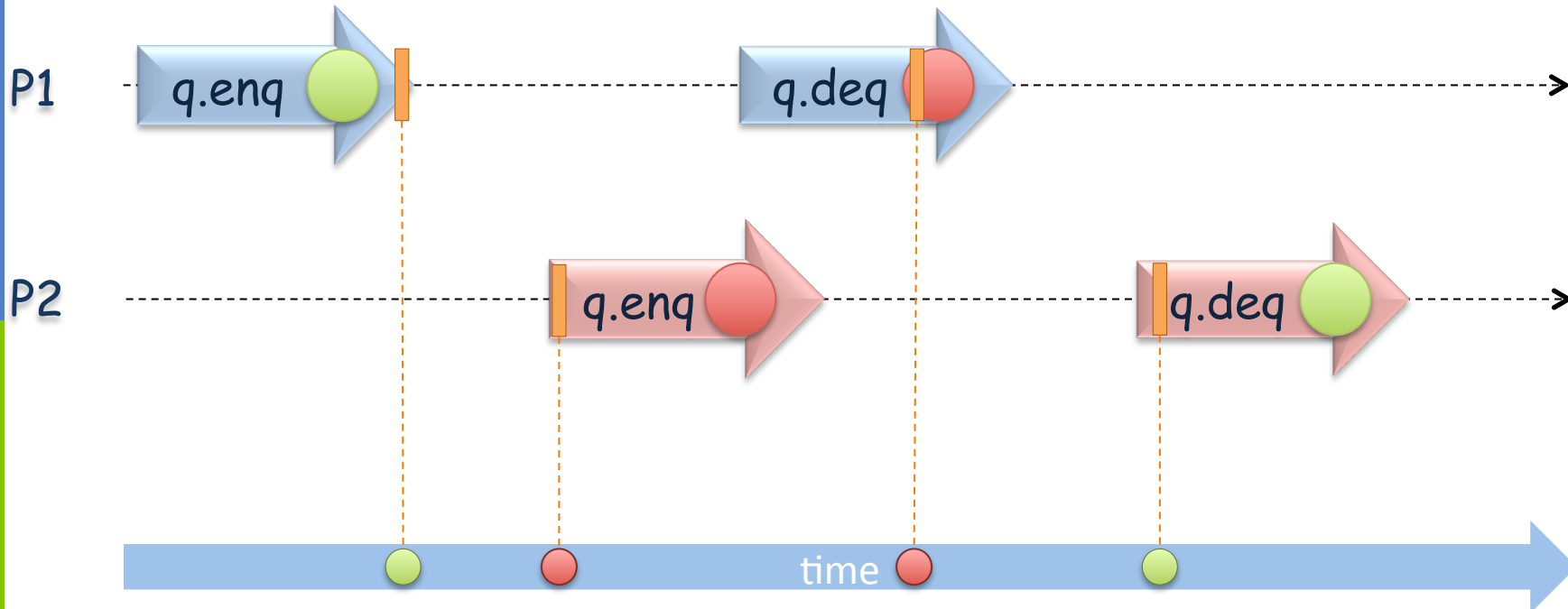
Linearizability

Is this execution linearizable? **No, BUT ...**



Linearizability

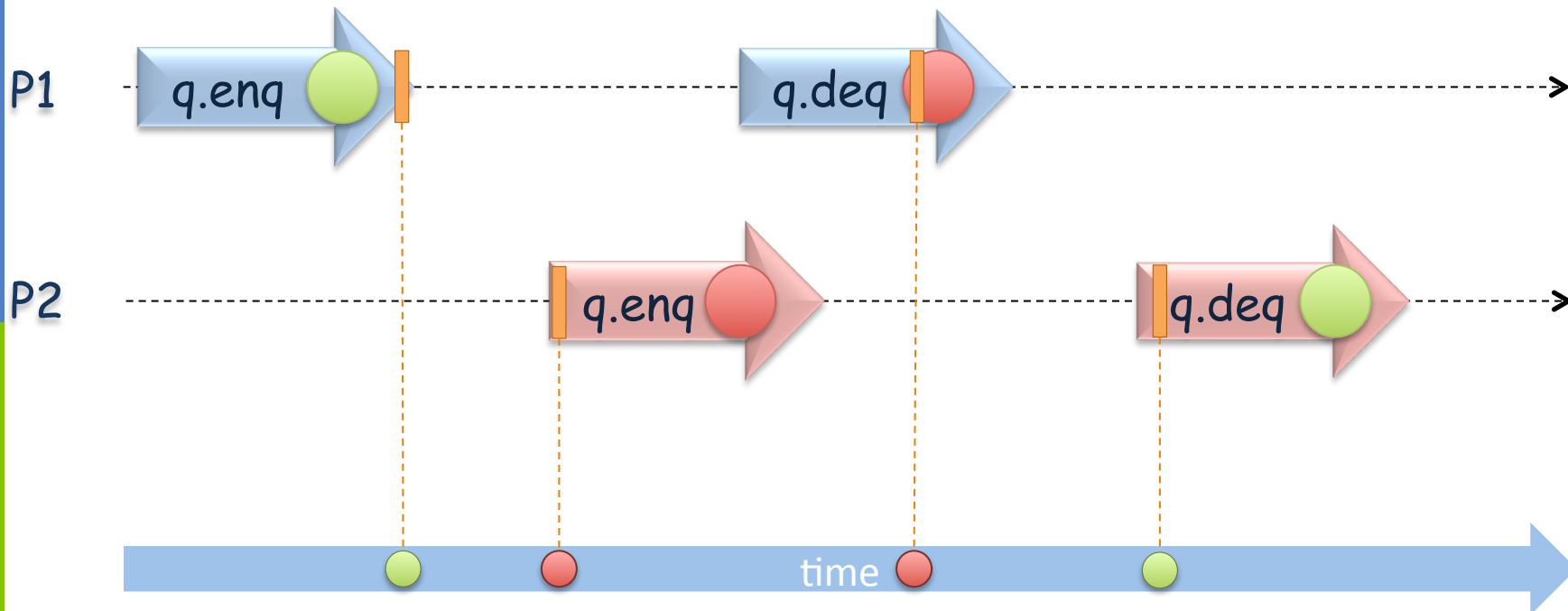
Is this execution linearizable? **No, BUT ...**



~~Linearizability~~

Serializability

Is this execution linearizable? **No, BUT ...**



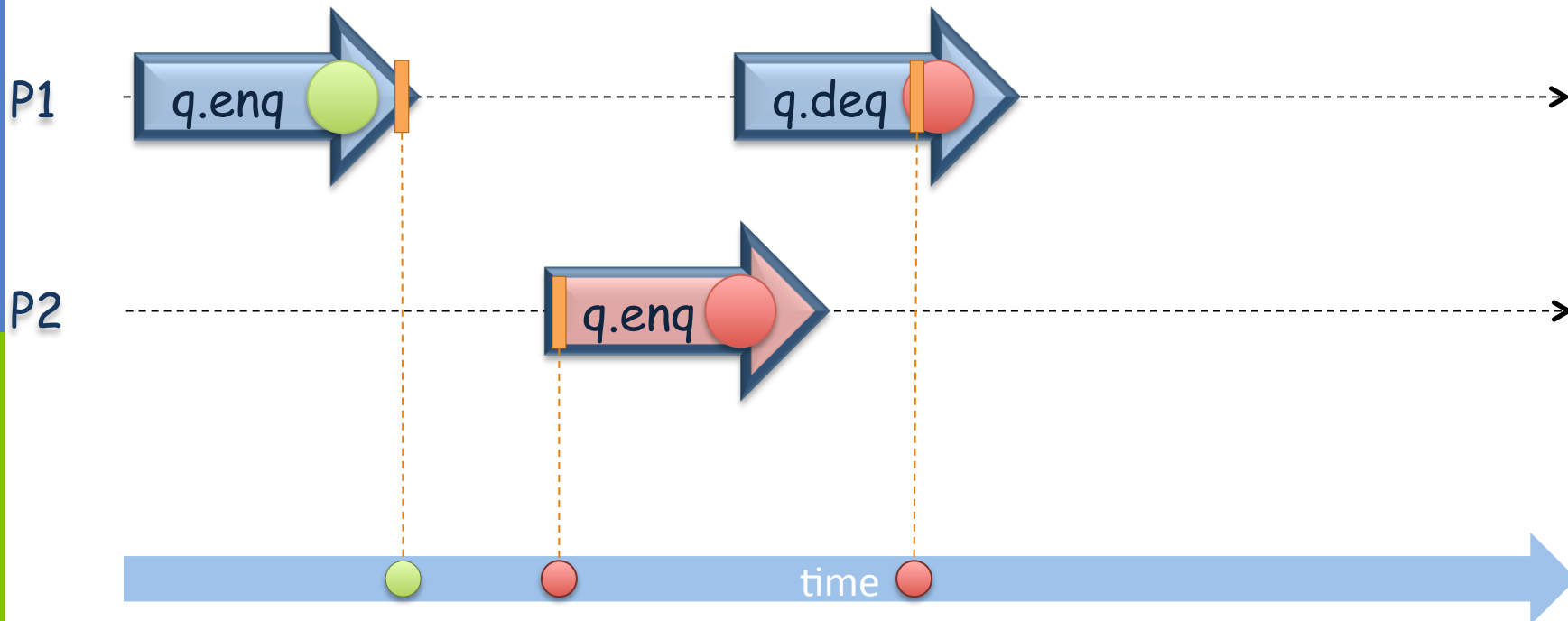
Serializability

- No need to preserve real time order
 - Can re-order operations done by the same thread
 - Can re-order non-overlapping operations done by different threads
- Each operation should “take effect” instantaneously
- The result of the concurrent execution of a program P must be equivalent to some sequential execution of the same program P

Serializability

Is this execution serializable?

Yes

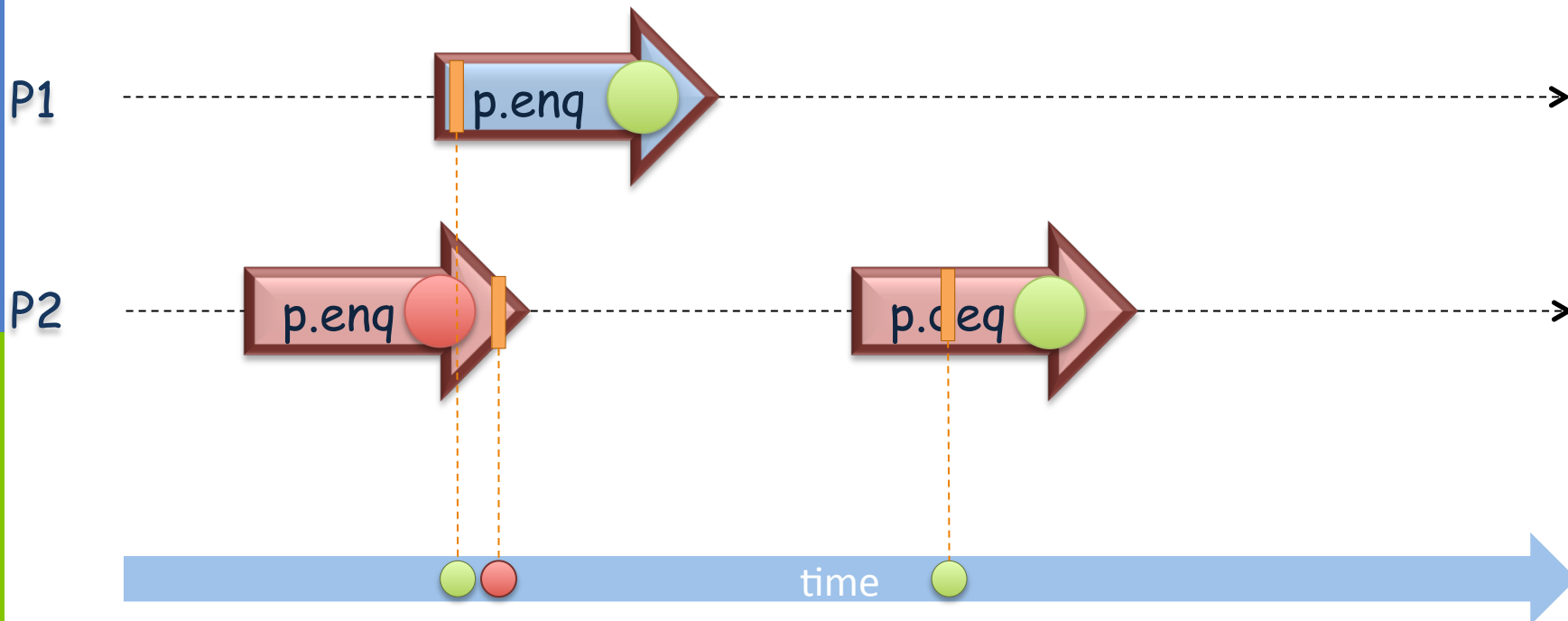


Serializable

Is this execution serializable?

Yes

It is also linearizable!



The End
