Mutual Exclusion: possibilities and impossibilities

Rob van Glabbeek

Data61, CSIRO, Sydney, Australia

University of New South Wales, Sydney, Australia

21 September 2021

Mutual exclusion: possibilities and impossibilities

Based on my paper at
http://theory.stanford.edu/~rvg/abstracts.html#156.

1. **FRAMEWORK:**

2. **DEFINITIONS:**

3. **IMPOSSIBILITIES:** ,

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   ME 1 ME 2 ME 3 ME 4 ME 5 ME 6

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   mutex

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   ME 1 ME 2 ME 3 ME 4 ME 5 ME 6
   mutex *starvation freedom*

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   The correctness requirements for mutual exclusion cannot be formulated in classical temporal logic.
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Centralised mutual exclusion protocol

Two processes P_1 and P_2 compete for access to the critical section.

$$P_i \stackrel{def}{=} \textsc{Noncrit}_i.\overline{\mathsf{request}_i}.\mathsf{enter}_i.\textsc{Crit}_i.\overline{\ell\mathsf{eave}_i}.P_i$$

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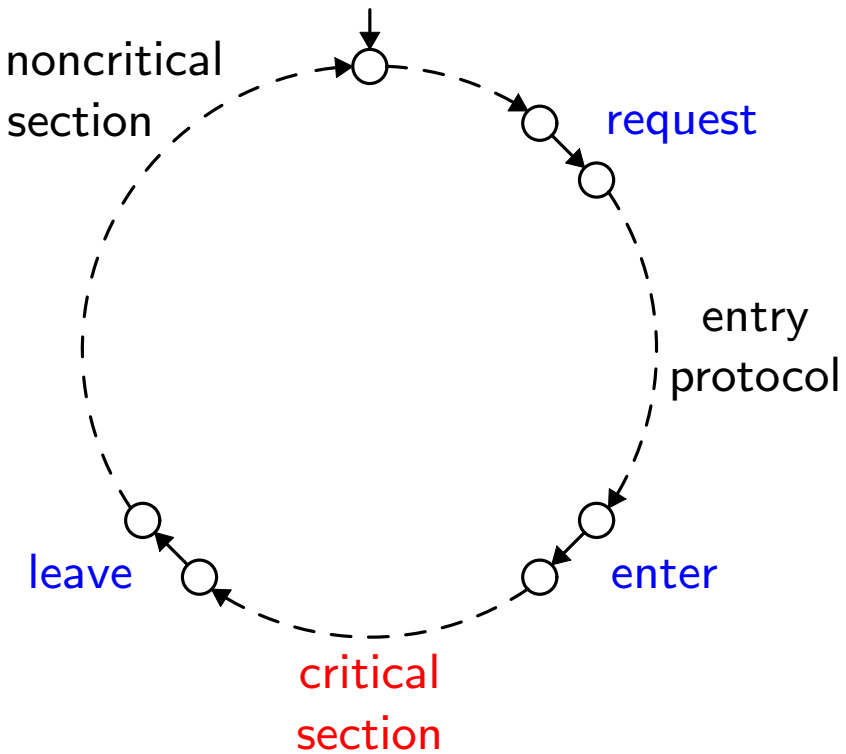

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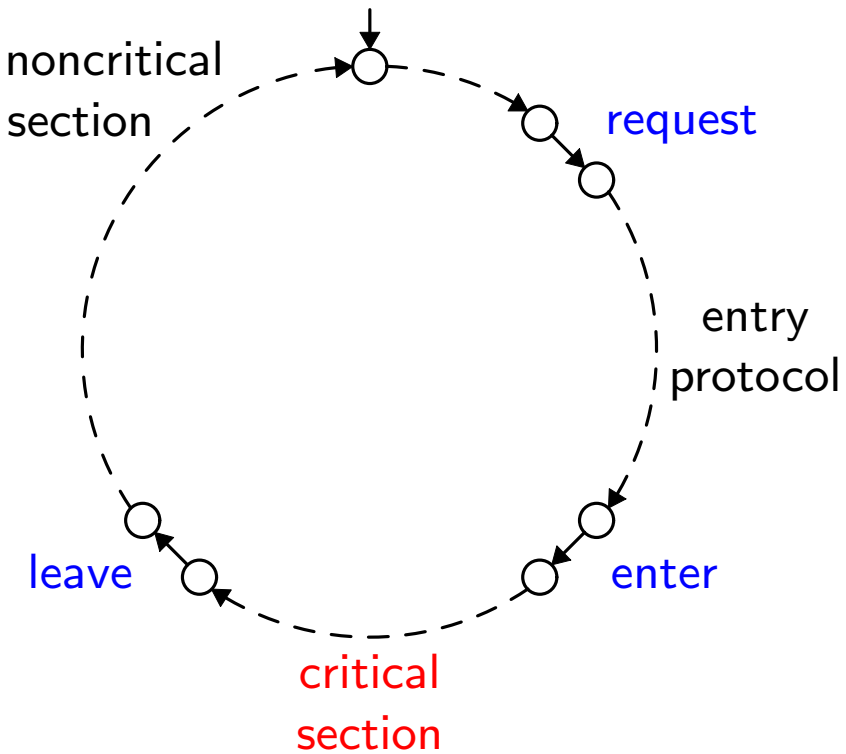

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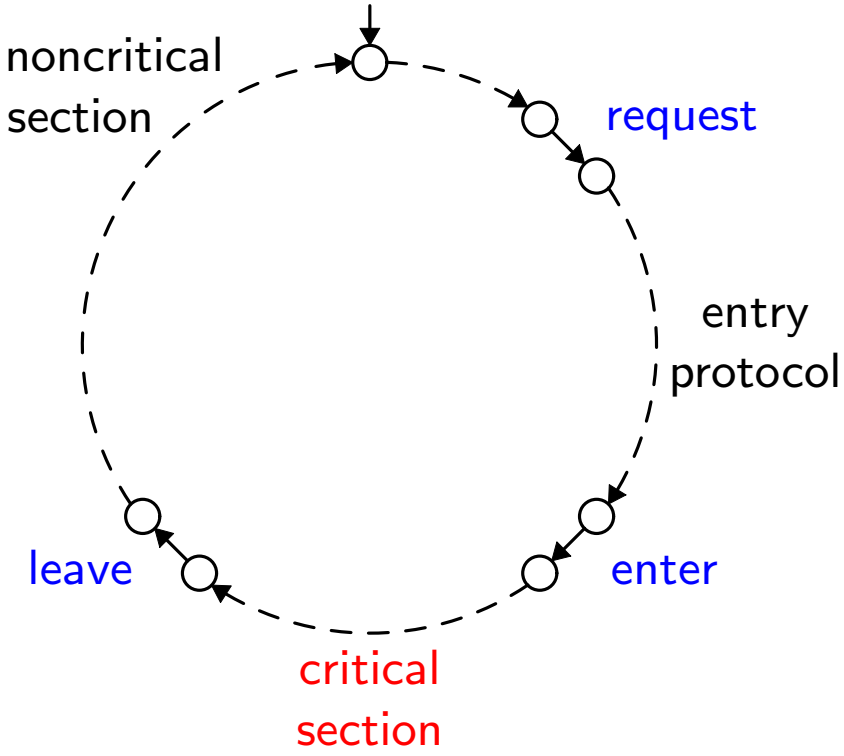

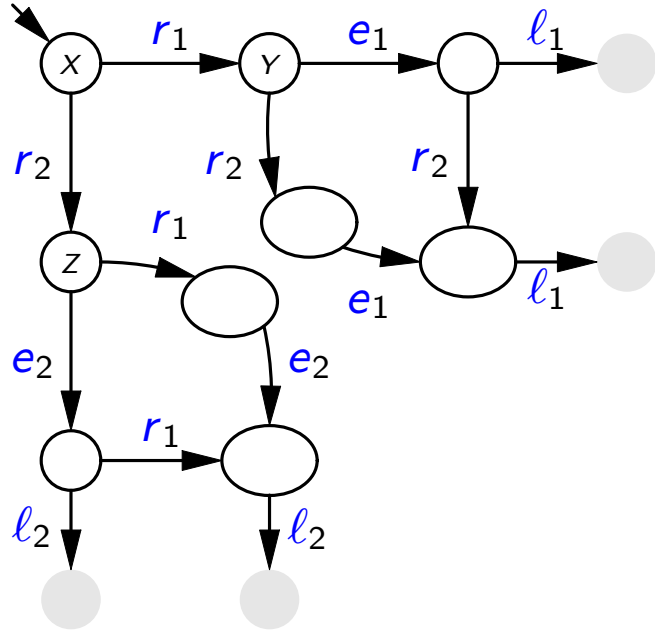

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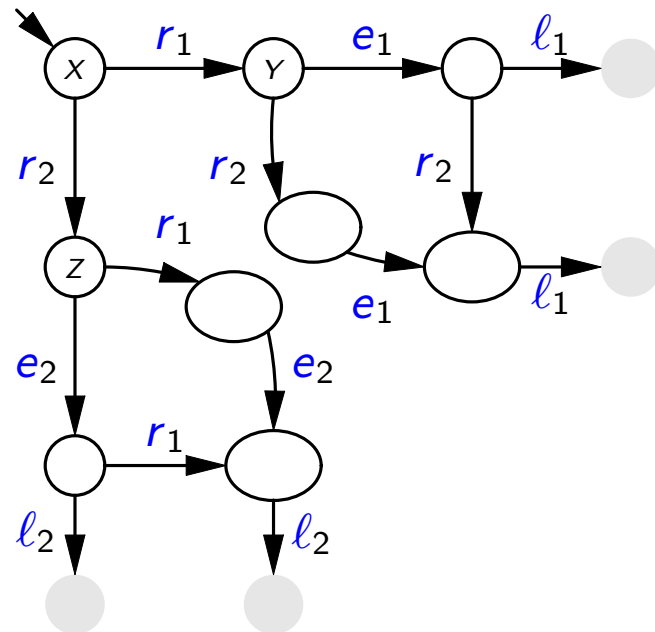

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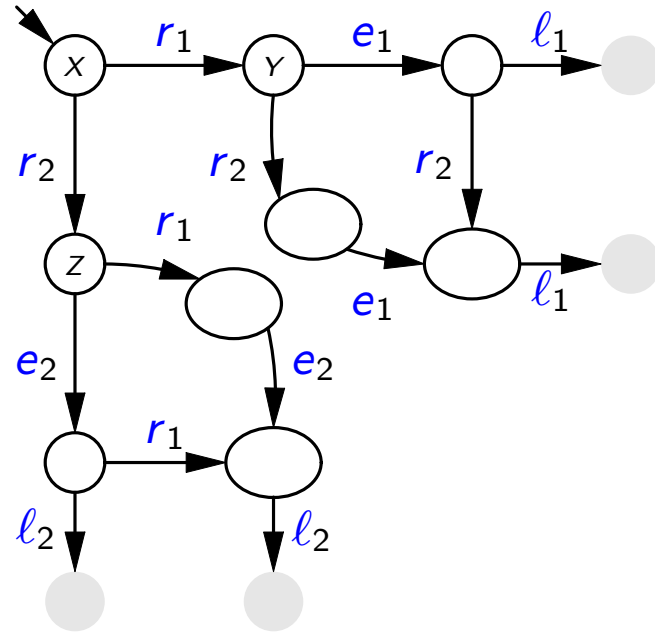

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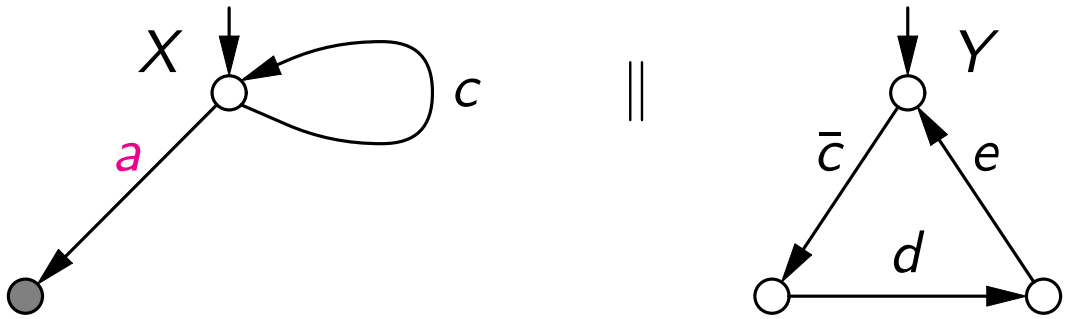

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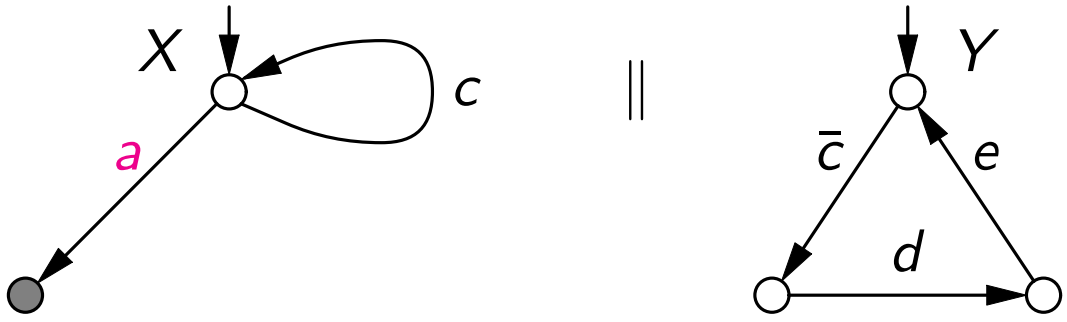

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Read and write actions on a shared memory

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Atomicity

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non-blocking reading

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atomicity:
a second memory access can take place only after a first is completed

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2. The register cannot handle a read and a write at the same time,
   but the write takes precedence and occurs when scheduled. This *aborts* the read, which can *restart* after the write is terminated.
3. The read and write proceed as scheduled, thus overlapping in time. "No assumption is made about the value obtained by a read that overlaps a write" [Lamport'86]

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My claim is that atomicity is the more challenging assumption.
For then there is no speed-independent mutual exclusion protocol.

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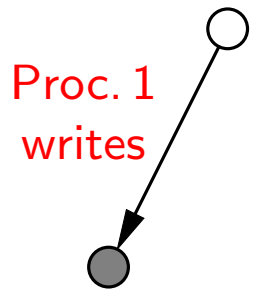

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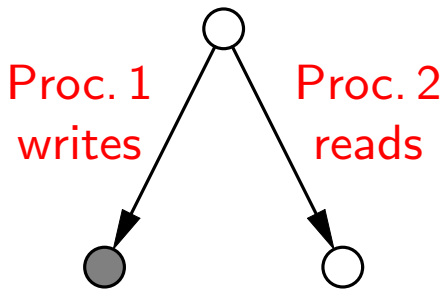

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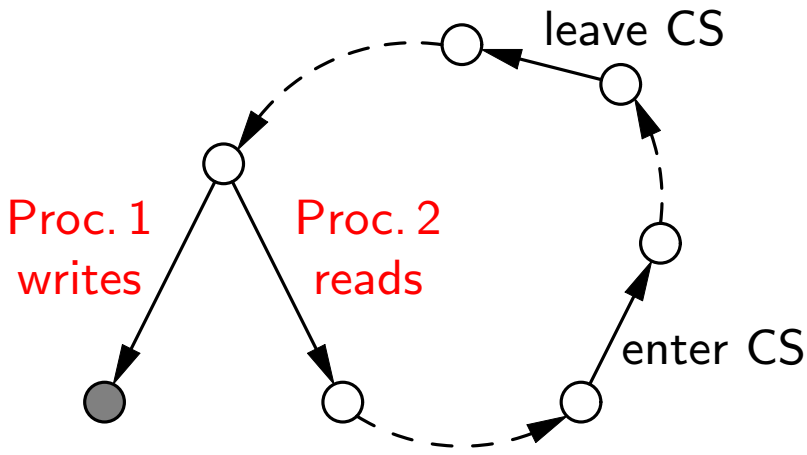

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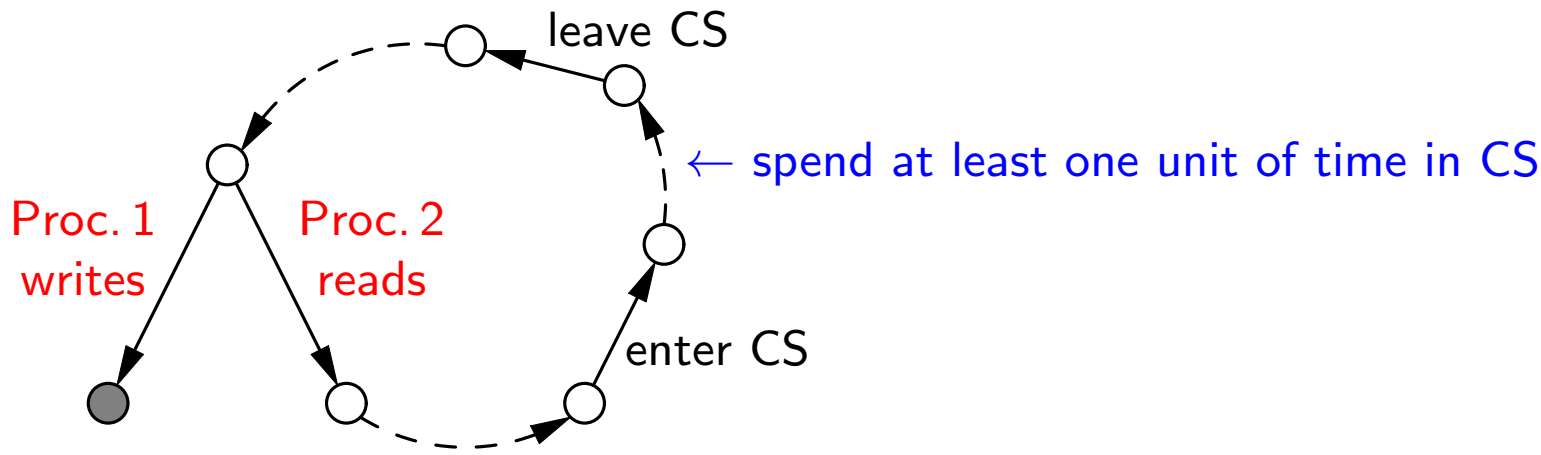

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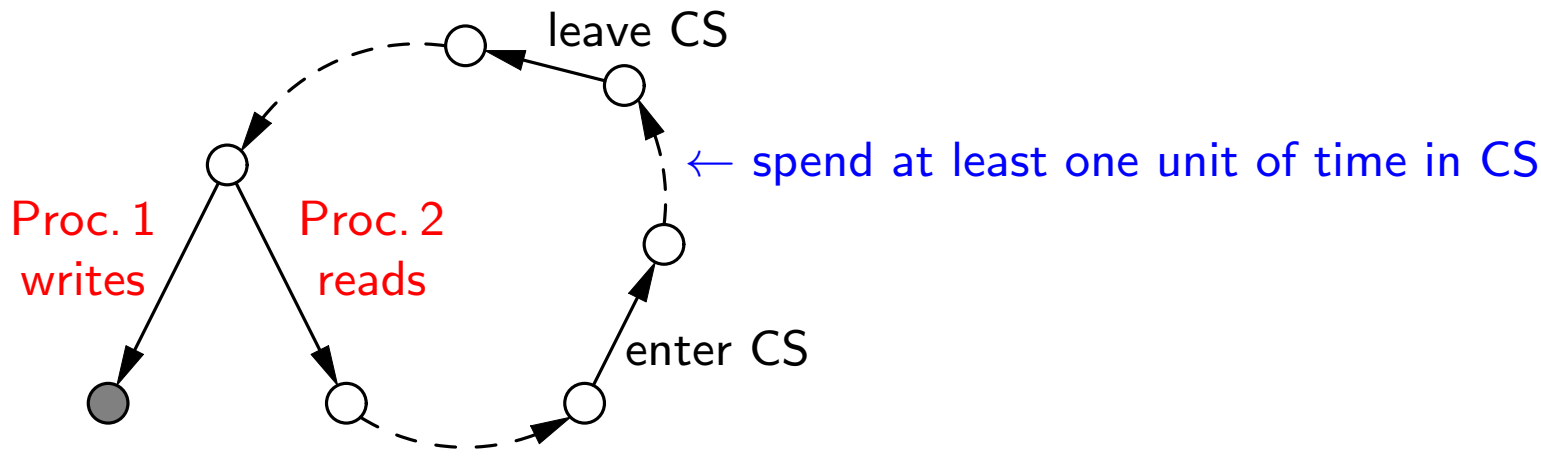

This can be neatly formalised in an untimed extension of CCS with timeouts.