Carl Adam Petri Memorial Symposium
February 4, 2011

Humboldt Universität Informatik

T o P
Theory of Programming

Concurrency based properties

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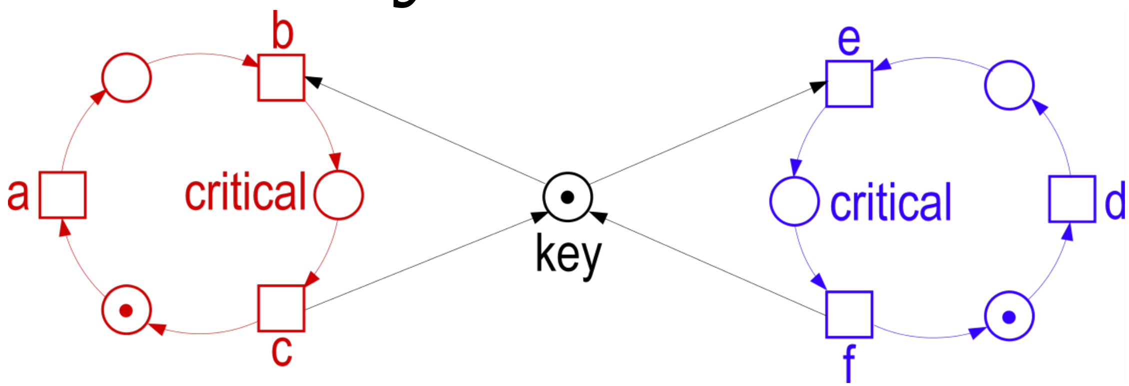
Prof. Dr. W. Reisig

A small example: The system of mutual exclusion

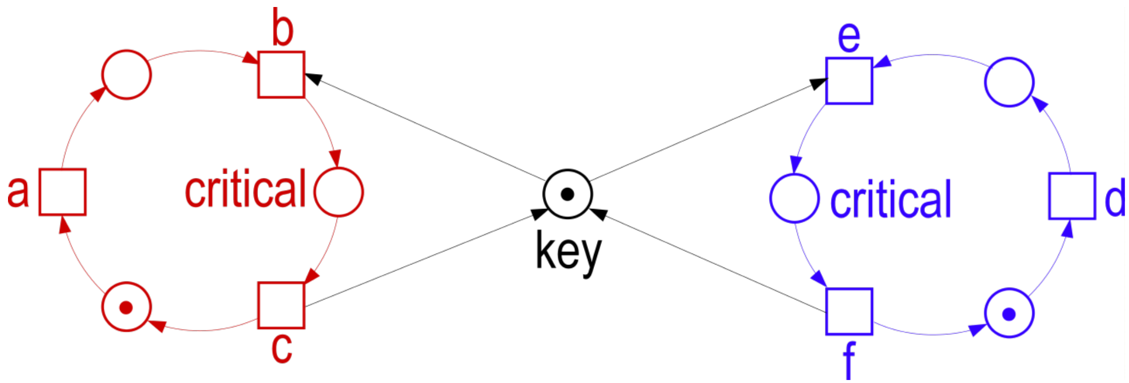


Observation: Different transition sequences may describe *the same behavior*.

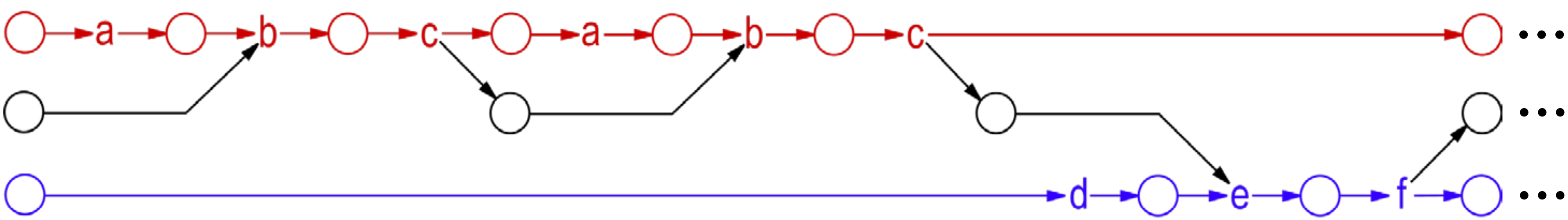
Typical transition sequences:	essential properties of the sequences:
abcdefabc …	*first red then blue*
abdcaefbc …	*then red again …*
abcabcdef…	*twice red then blue*
abdcabcef…	*then …*

What, precisely, is *“the behavior” described by a transition sequence?*

As Carl Adam Petri told us in the late 1970ies:



A *behavior* is a partially ordered set of transition occurrences:

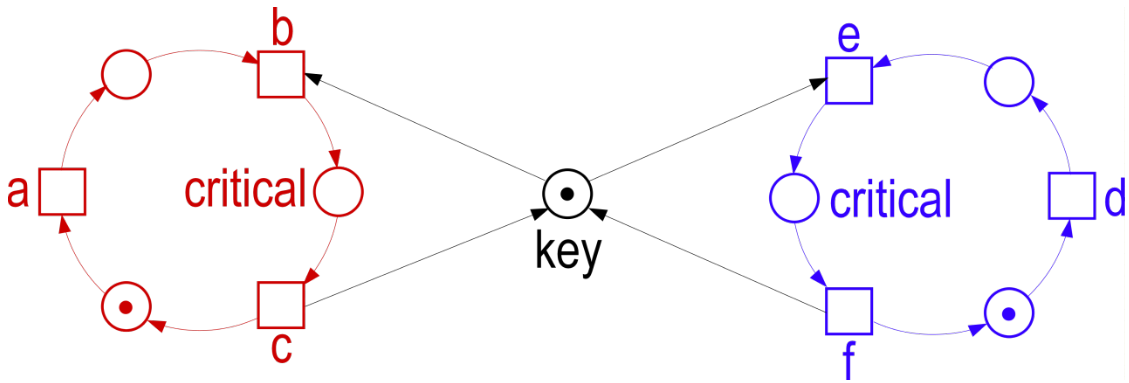


Two total extensions of this partial order:

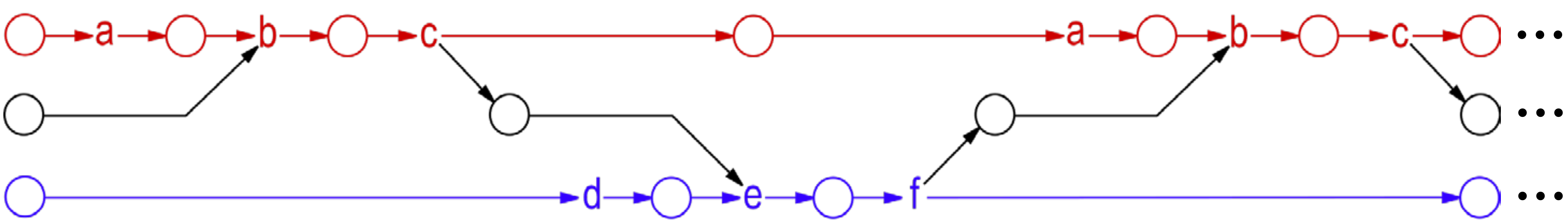
abcabcdef…

abdcabcef…

As Carl Adam Petri told us in the late 1970ies:



A different behavior:

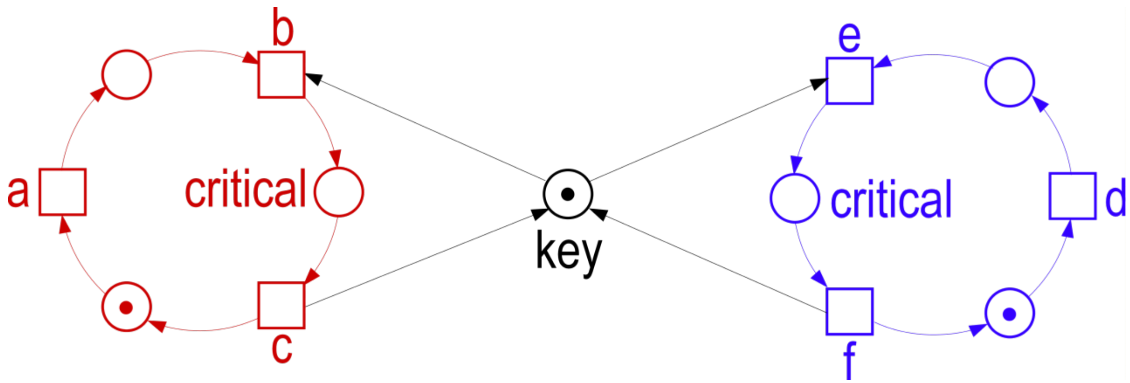


Two total extensions of this partial order:

abcdefabc …

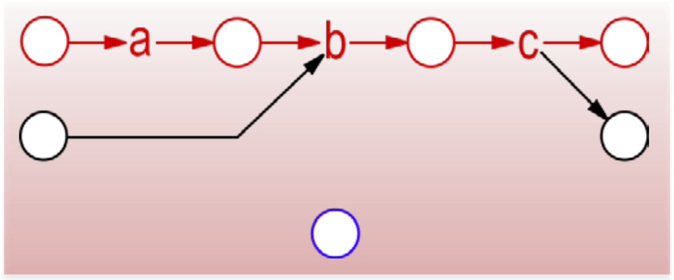
dabcaefbc …

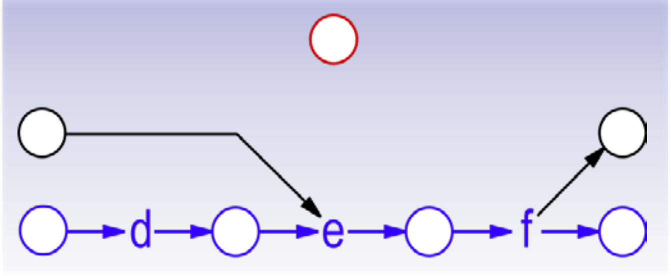
Scenarios



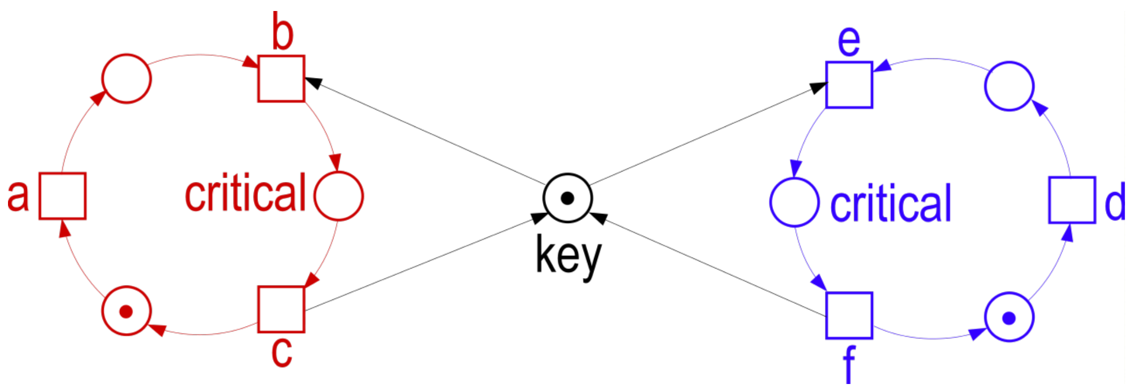
Def.: A *scenario* is a finite piece of behavior.

Two scenarios:



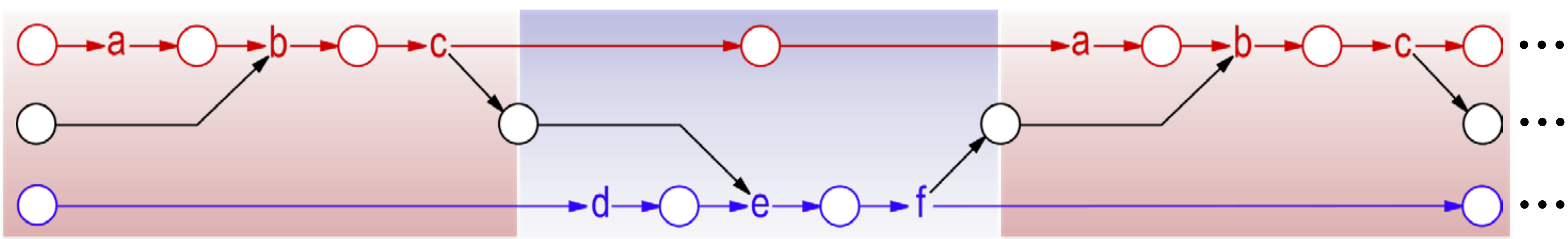


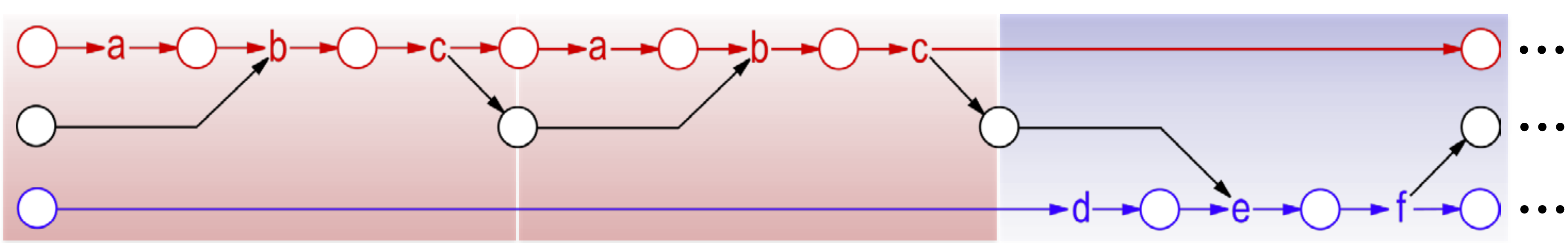
Scenarios configure a behavior.



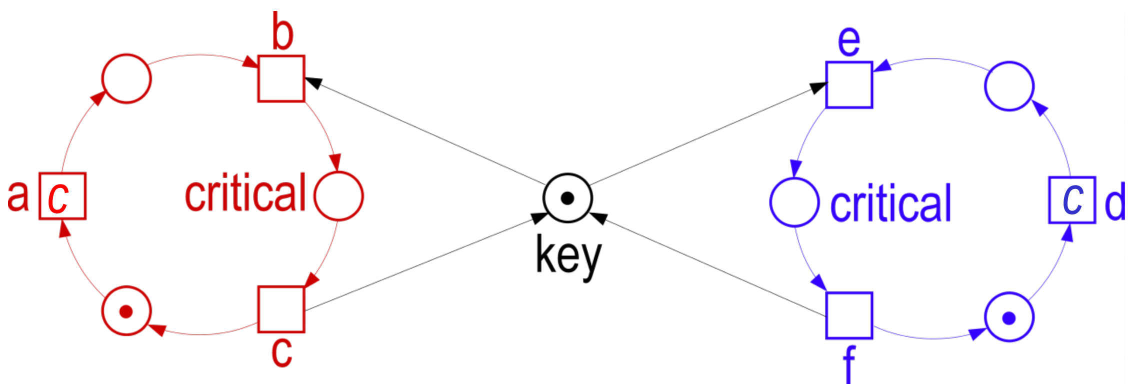
Def.: A *scenario* is a finite piece of behavior.

Each above behavior is a sequence of instances the two scenarios:



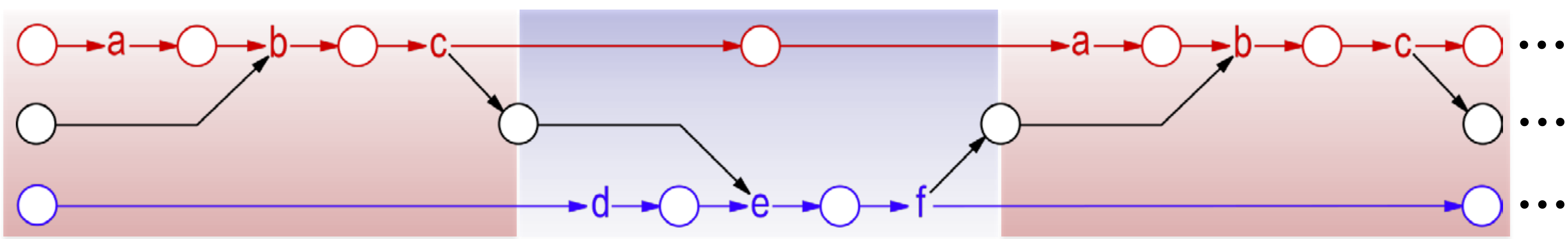


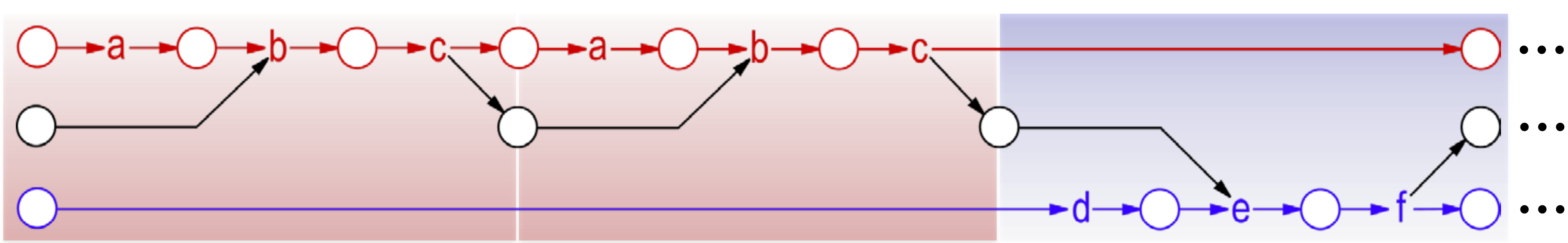
How capture the *finite* behaviors?



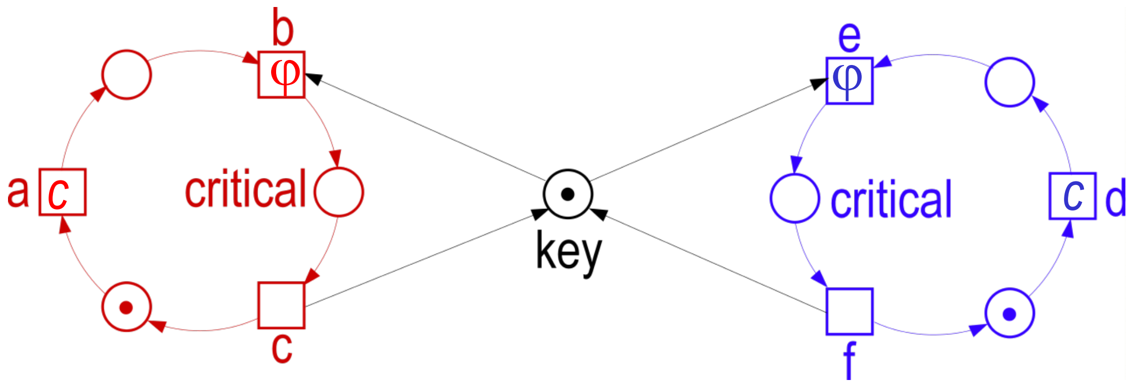
… by means of
cold transitions a and d
(taken from
Harel's statecharts)

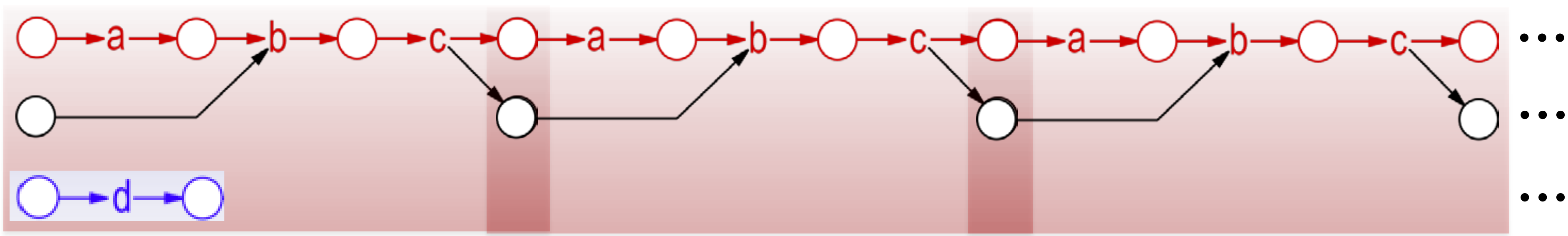
Each above behavior is a sequence of instances the two scenarios:





A nasty behavior



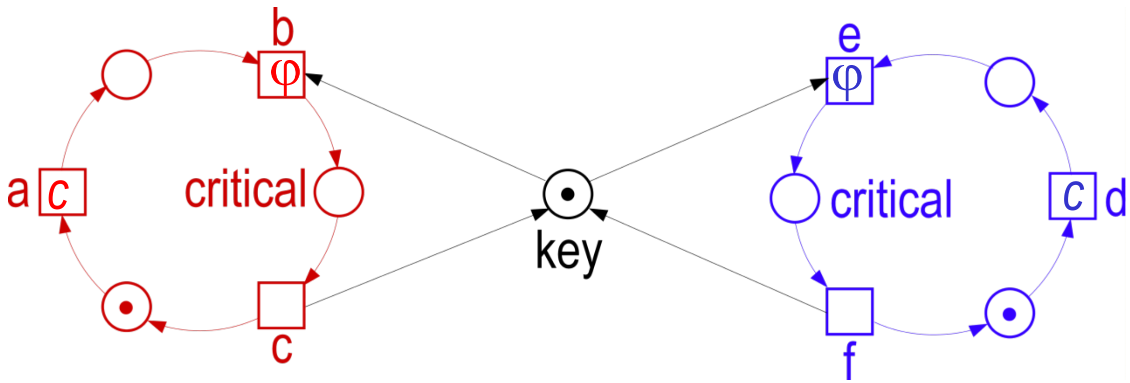


(This behavior is *not* composed of the above scenarios.)

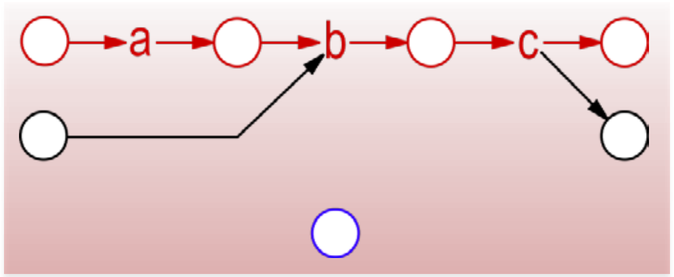
Idea: Exclude this behavior, assuming *fairness* for e.

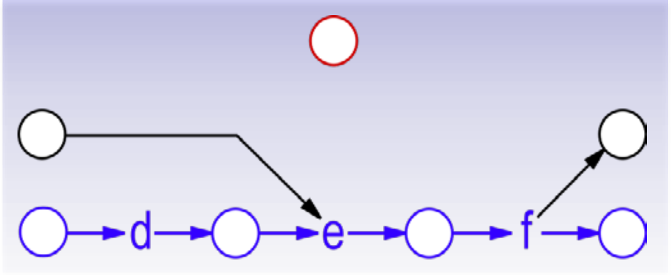
… and for b

This completes MUTEX



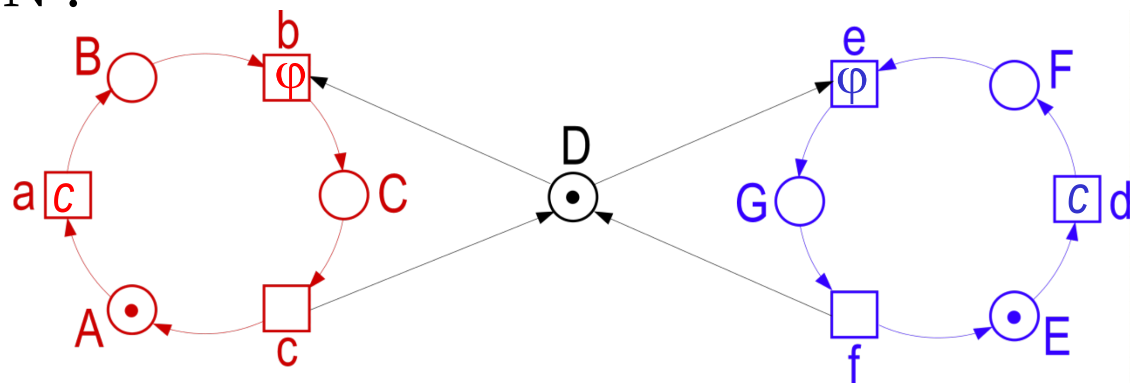
Each behavior is a sequence of instances two scenarios:





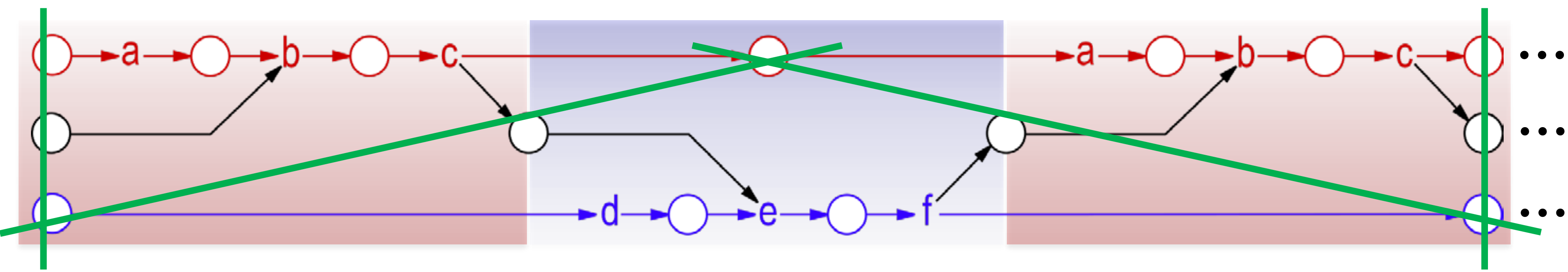
A decisive property

N :



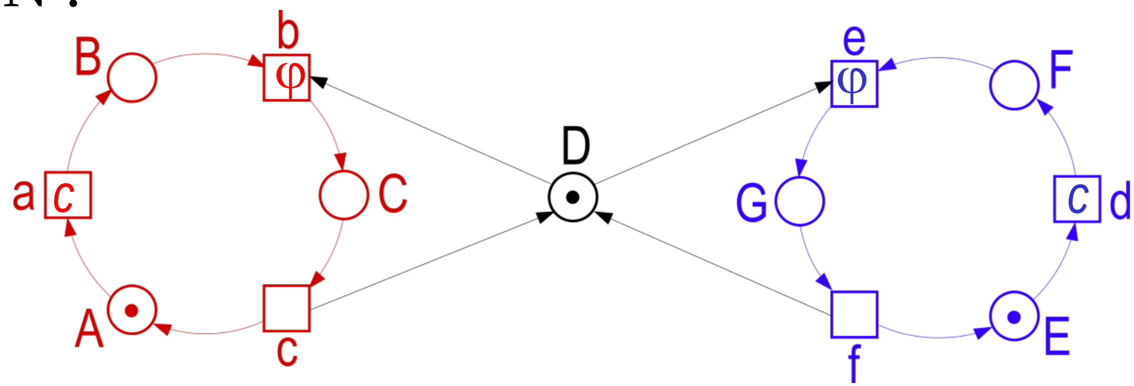
Every reachable state is eventually followed by *ADE* :

ADE is a *home state*.



How *represent* this property?

N :



ADE is a *home state*:

Every reachable state is eventually followed by *ADE* .

Does temporal logic help? $N \models \Box \Diamond ADE$????.

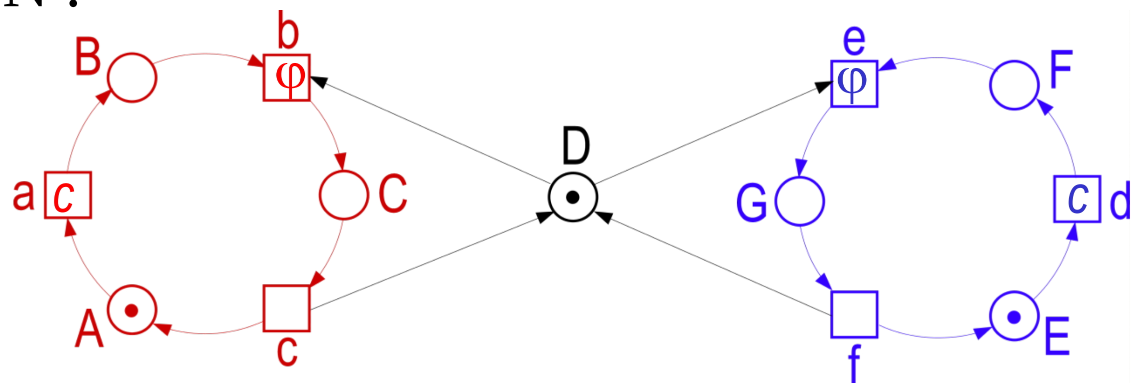
branching time: too weak ($N \models \Box \Diamond ADE$ also without φ)

linear time: too strong ($N \not\models \Box \Diamond ADE$)

required: “To *each* behavior *there exists* a transition sequence …

How *prove* this property?

N :



By help of a *proof graph:*

First observe:

Two steps leave ADE:

Then due to φ:

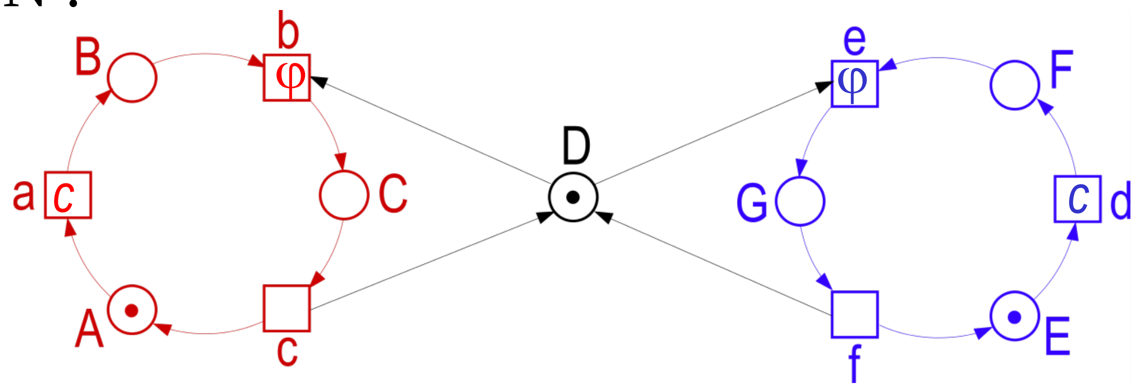
Then due to locality:

$$\begin{tikzcd}
& BDE \arrow[rr, "b"] & & CE \arrow[dr, "c"] & \\
ADE \arrow[ur, "a"] \arrow[dr, "d"'] & & & & ADE \\
& ADF \arrow[rr, "e"] & & AG \arrow[ur, "f"'] &
\end{tikzcd}$$

correspondingly :

Summing up

N :



There are important properties of distributed systems

(e.g. “N has just two scenarios”; “ADE is a home state”) that

- depend on partially ordered behaviors,
- can not (easily) be expressed
  by means of transition sequences,
- can nevertheless be proven by simple means.

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thanks for your interest

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Programming

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