Concurrency based properties

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A small example:
The system of mutual exclusion

Typical transition sequences:

- abcdefabc...
- abdcaefbc...
- abcabcdef...
- abdcabcef...

Essential properties of the sequences:

- First red then blue
- Then red again...
- Twice red then blue
- Then...

Observation:
Different transition sequences may describe the same behavior.

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 ...
da bac efbc ...
```
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?

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

... by means of *cold* transitions a and d (taken from Harel’s statecharts)
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

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?  \( N \models \square \Diamond \text{ADE} \) ????.

*branching time*: too weak  ( \( N \models \square \Diamond \text{ADE} \) also without \( \varphi \) )

*linear time*: too strong  ( \( N \not\models \square \Diamond \text{ADE} \) )

*required*: “To each behavior there exists a transition sequence …"
How *prove* this property?

By help of a *proof graph*:
First observe:
Two steps leave $ADE$:

Then due to $\varphi$:
Then due to locality:

correspondingly:
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,
- cannot (easily) be expressed by means of transition sequences,
- can nevertheless be proven by simple means.
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thanks for your interest