

Probabilistic models and concurrent systems

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Probabilistic concurrent systems

A work in collaboration with A. Benveniste (2004-2009).

- A **framework** to randomize *non-sequential* processes
- Models of *event structures* and 1-bounded *Petri nets* under their *partial orders* semantics
 - A Petri net defines a regular event structure

Some features of the model

- Localizes the **state space**
 - *Branching cells*: a notion of “local state” for Petri nets and event structures different from place or transition
 - Homogeneity of the probability yields *Markov nets*
- Local actions that occur concurrently are **independent in probability**
 - dynamical *product form* of the probability distribution of processes
- **For comparison:**
 - A *Markov chain* is completely sequential (no concurrency, trivial product form with 1 component)
 - *Independent random variables* are completely concurrent and never synchronize
 - *Markov nets* are a mixture of these

Bug or Feature? Time

- *NO* totally ordered time
- The global clock is *partially ordered*
 - understandable when thinking of several usual clocks running in parallel and synchronizing at some instants only
- *Not compatible* with a Markov chain running on the state space of a Petri net
(natural endowing sequential model → partially ordered model)

Bug or Feature? Time

Consequence:

- Markov nets are not a temporised model

Question:

- Can Markov nets help for modeling a system with physical time?
 - PANDA will hopefully help me answering the question, by analyzing Airbus data
 - The methodology for validating the model is still not set up

Advantages of the model; challenges

Advantages:

- *Local* estimation, *local* learning. Needs more advances in the ergodic theory of the model
- Diagnosis and observation is *order-independent* for concurrent events

Challenges:

- *Ergodic theory*: explore the notions of convergence for partially ordered time processes
 - beyond the usual generalization from “ $n \rightarrow \infty, n \in \mathbb{N}$ ” to “ $i \rightarrow \infty, i$ in a directed set”
- *Composition*. Some steps have been done in this direction [Abbes et Benveniste, 2008, HAL-published].

Probabilistic PANDA

- Validation of a partial orders probabilistic model for the modeling of a temporised system. The answer is not obvious.
- Advances in ergodic and learning theory of distributed systems
- Composition of concurrent probabilistic systems
- Members:
 - C. Palamidessi (LiX)
 - S. Abbes (P7, PPS)
 - M.-A. Steineur (PhD to start)
 - Whoever's interested