I. Summary of the Tutorial

Product-form models are a class of Markovian models whose steady-state solution can be computed efficiently thanks to a separable equilibrium probability distribution. They first appeared in queuing theory with the well-know result of Jackson networks. Many research efforts have been devoted to the identification of new product-form models both for queuing networks and other formalisms (e.g. for Markovian process algebra or for stochastic Petri nets etc.). The results presented in [1], [2], [3] allow the computation of the product-form solutions of Markovian models via structural analysis of their underlying processes and constraints on the rates of the corresponding reversed processes. These results greatly simplify the derivation of product-form solutions, as they offer a constructive way to establish whether a Continuous Time Markov Chain (CTMCs) has product-form solution. Furthermore, we show how they can be applied to provide a practical methodology to transform models which are not in product-form, into approximated one that do enjoy product-form solution [4]. The methodology is presented by using the representation of CTMCs as Labelled Markov Automata since this formalism appears to be of simple use independently of the audience background.

The various results mentioned earlier have successfully been applied to prove both well-known product-form solutions and new ones.

Since the results are formulated purely in abstract Markovian setting they may be applied also for non-queueing models.

The tutorial will be of great interest to an ample audience, well beyond researchers working on queuing theory and it aims to give both a theoretical overview on the results mentioned above and their practical applications to modelling.

It is structured in three parts:

Introduction of product-form models: Basic notions about product-form solutions of stochastic models and an overview of cooperating Labelled Markov Automata will be given.

Reversed Compound Agent Theorem (RCAT) and its generalisation: The results [1], [3] will be presented in detail. Particular attention will be devoted to practical implications and several examples will be provided. In particular, Jackson networks, G-networks and some non queueing product-forms will be considered as special cases.

Extended Reversed Compound Agent Theorem (ERCAT/MARCAT): A set of models which are known to be in product-form cannot be analysed by previous results [1], [3]. This is the case for queuing networks with finite capacity and blocking and for the product-form derived for Stochastic Petri nets. This part of the tutorial illustrates the Extended Reversed Compound Agent Theorem and its extension to arbitrary number of cooperating CTMCs [2]. This latter result covers the product-form analysis of a wider class of models, but its application is significantly less efficient from a computational point of view with respect to [1], [3]. Comparison between the two results will be highlighted, and explained with practical examples. Also in this case several well-known results will be shown to be special cases (specifically, queueing networks with blocking and Stochastic Petri nets analysis will be considered [5]) and new ones will be derived.

REFERENCES


