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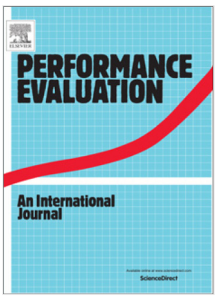

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Nigel Bean, Giang T. Nguyen, Federico Poloni

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Doubling Algorithms for Stationary Distributions of Fluid Queues: A Probabilistic Interpretation

Nigel Bean* Giang T. Nguyen* Federico Poloni†

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Abstract

Fluid queues are mathematical models frequently used in stochastic modelling. Their stationary distributions involve a key matrix recording the conditional probabilities of returning to an initial level from above, often known in the literature as the matrix Ψ. Here, we present a probabilistic interpretation of the family of algorithms known as *doubling*, which are currently the most effective algorithms for computing the return probability matrix Ψ.

To this end, we first revisit the links described in [19, 11] between fluid queues and Quasi-Birth-Death processes; in particular, we give new probabilistic interpretations for these connections. We generalize this framework to give a probabilistic meaning for the initial step of doubling algorithms, and include also an interpretation for the iterative step of these algorithms. Our work is the first probabilistic interpretation available for doubling algorithms.

Keywords: doubling algorithms; stochastic fluid flows; quasi-birth-death processes; stationary distribution

1 Introduction

Stochastic fluid queues are two-dimensional Markov processes frequently used for modeling real-life applications. In a fluid queue $\{X_t, \varphi_t\}_{t\geq 0}$, the *phase* φ_t is a continuous-time Markov chain on a finite state space $\mathcal{S}$, and the *level* $X_t \in (-\infty, \infty)$ varies linearly at rate c_{φ_t}. We consider the associated regulated process $\{\overline{X}_t, \varphi_t\}_{t\geq 0}$ that has a boundary at 0:

$$\overline{X}_t := X_t - \inf_{0\leq s\leq t} X_s.$$

*The University of Adelaide, School of Mathematical Sciences, SA 5005, Australia, and ARC Centre of Excellence for Mathematical and Statistical Frontiers {nigel.bean,giang.nguyen}@adelaide.edu.au

†Università di Pisa, Dipartimento di Informatica, Pisa, Italy, federico.poloni@unipi.it