GRnet – A tool for Gnetworks with Restart

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ABSTRACT

Gnetworks extend standard queueing networks as to include different types of customers or jobs. In addition to ordinary jobs also signals, or negative jobs can arrive to a queue. A signal removes a job from the queue instead of adding one. The interpretation of a signal as retry is very natural and induces semantics to the arrival of a signal. The job that is hit by the signal first leaves the queue but then immediately returns as a new job.

The mathematical specification of Gnetworks with retry has become a cumbersome task. Therefore we present in this tool-demo paper a new tool that will support the specification and analysis of Gnetwork models with retries.

1. INTRODUCTION

In a network of queues with signals (also denoted as a Gnetwork of queues)[2] customers are allowed to change to signals at the completion of their service and signals interact at their arrival into a queue with customers already present in the queue. Signals, or negative customers are never queued. They try to interact with customers and disappear immediately. Note that they may fail to interact with some probability or due to some conditions which are not satisfied. Despite this deep modification of the model, G-networks still preserve the product-form property for the steady-state distribution of some Markovian queueing networks.

In [1] Gnetworks have been used to model queueing systems with restart. The restart of a job is represented as the arrival of a signal that will restart the normal job it interacts with. The model in [1] is fairly general in that it uses phase-type (PH) distributions for the service-time distributions [3], in order to be able to reflect characteristics of real systems.

Unfortunately, the definition of such models is a laborious task, even if the network only consists of very few queues. The tool presented in this paper addresses this shortcoming. It primarily aids in the specification of Gnetwork models with restart as defined in [1] and solves a class of rather simple models that have only one queue. An extension to real queueing networks with several queues is currently in progress.

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2. MODEL SPECIFICATION

The GRnetwork editor is shown in Figure 1. Using drag and drop the model objects can be placed into the editor window and connected following their correct syntax. Most models contain two sources, one for normal jobs and an optional source generating signals. Both sources feed jobs into the queue, or remove and restart them.

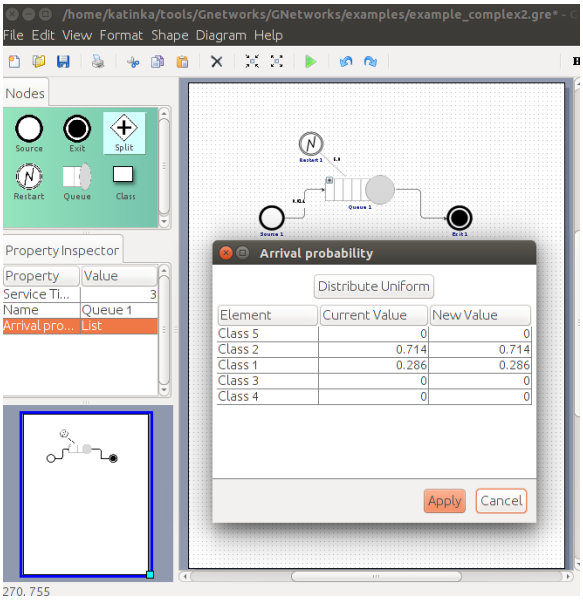

Figure 1: GRnetwork Editor

Figure 2 shows the queue in expanded representation such that the class structure becomes visible. Arriving jobs can be assigned to different classes and jobs can move from one class to the next upon restart. The transitions between classes are shown in the figure. A phase-type (PH) distributed service time distribution is assigned to each job class with service rate μ in each phase and retry success probability α in each phase. In the given example restart signals are accepted with probability 1 by a regular job being served in one of the PH phases. One could refuse restart signals while job service is in a certain phase of the PH dis-

tribution. In the simplest case the service time follows an exponential distribution. Any arbitrary PH distribution is possible, e.g. the hyper-erlang distribution fitted to empirical data using HyperStar [4]. Upon completion jobs leave

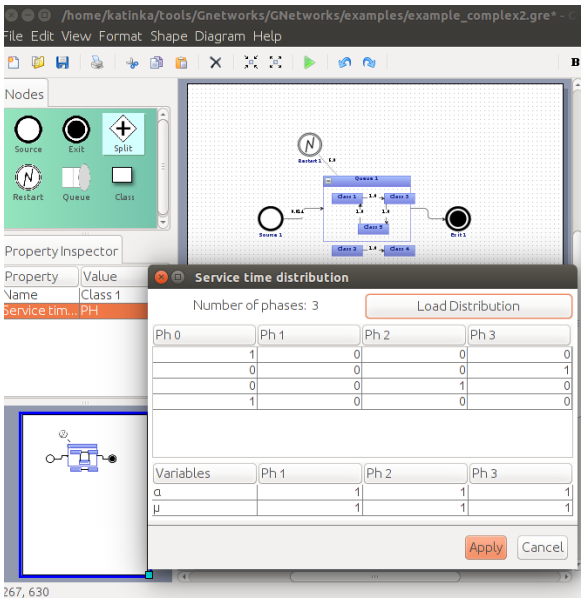

Figure 2: GRnetwork Editor

the queue into the sink. For routing between queues and arrivals from one source into several queues a split object must be used as shown in Figure 4.

3. MODEL ANALYSIS

The model solution provides the utilisation ρ which can be used to compute many metrics of interest. The utilisation can be computed either for a fixed parameter set, or it can be minimised with respect to the restart rate, i.e. arrival rate of signals. Optimisation can be done using a series computation or a Newton algorithm for successive approximation as shown in Figure 3.

Current work extends the tool to several queues as to represent more realistic and more complex systems with job routing between queues. Such a model could be used to study for instance load balancing, as shown in Figure 4.

4. CONCLUSION

We present a tool for editing and solving Gnetworks with restart. The tool will be made available at `http://www.mi.fu-berlin.de/inf/groups/ag-tech/projects/Dependable_Systems/-index.html`.

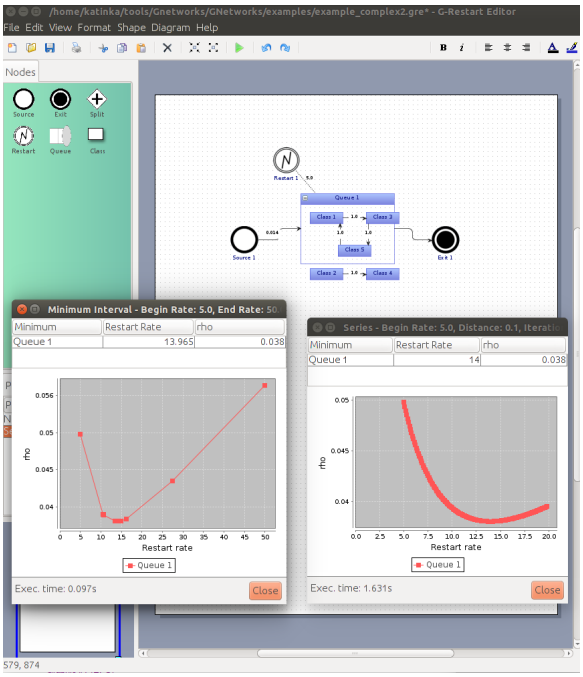

Figure 3: Network solution

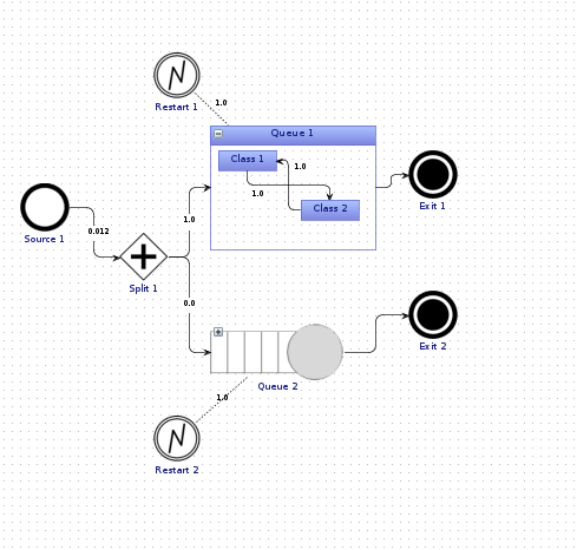

Figure 4: Network with two queues

5. REFERENCES

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