Conclusions

Discrete time multiserver queueing system governed by a discrete autoregressive process of order 1 [DAR(1)] with a particular marginal distribution is an appropriate model for Asynchronous Transfer Mode [ATM] Multiplexer with VBR coded Teleconference traffic. DAR(1) is described by a few parameters and it is easy to match the probability distribution and the decay rate of the autocorrelation function with those of measured real traffic. The input traffic may consist of positive as well as negative arrivals.

In this thesis we have considered the arrival process of the multiserver queue is considered as [DAR(1)] with Quasi-Negative Binomial Distribution-II, discrete stable distribution and Discrete Mittag-Leffler distribution as marginal and used to analyze the ATM input traffic with positive arrivals only. The stationary distribution of system size as well as waiting time of an arbitrary packet are computed with the help of Matrix Analytic Method and Markov regenerative processes. From the definition of autocorrelation function, the larger the parameter $\beta$, the slower the decay of the autocorrelation of the input process. It is verified that stationary system size and waiting time for the case of large $\beta$ are stochastically
larger than those for the case of small $\beta$. Also the stationary system size and waiting time increases when the input parameter of the marginal distribution decreases. We applied these queueing systems with respect to real data sets.

The ATM traffic with positive as well as negative arrivals are modeled as DAR (1) arrivals with discrete skew Laplace as marginal distribution. Since discrete skew Laplace can accommodate both positive as well as negative arrivals simultaneously, it is an appropriate model for analyzing the effect of virus in the computer systems. Ordinary queueing system can not be used in this situation. Here also the stationary distribution of system size and waiting time of an arbitrary packet are computed through the matrix analytic method and Markov regenerative processes. Stationary system size and waiting time is stochastically increases as the parameter of the marginal distribution increases. We applied these queueing systems with respect to real data sets.

A new count model based upon Mittag-Leffler inter arrival time distribution is introduced in this thesis. More importantly, the model provided a sizeable improvement over the more traditional Poisson process. One important advantage of the new model is that it removed the artificial symmetry between overdispersion and equidispersion, a violation of the constant hazard assumption underlying the Poisson model. This new model can be treated as a generalization of the Poisson process. The new model has closed form nature and computation is possible using MATLAB and R packages. This new model can be applied to real data sets where the assumption of equidispersion is violated.

A new count model based upon Gumbel inter arrival time distribution for studying the climate variability is also introduced in this thesis. This new model also removed the artificial symmetry between overdispersion and equidispersion. The assumption of the constant hazard function of the Poisson model is violated. This new model can be treated as a generalization of the Poisson process as well a The new model as closed form nature and computation is possible using Matlab and R packages. This new model can be applied to real data sets of climate where the assumption of equidispersion is violated.

From the study of relationship between the number of Chikungunya incidence and
data sets on climate change during 2005-2007 in Kerala, it is clear that the epidemics is correlated with the climate change. To forecast the epidemics like chickungunya as well as for the prediction of climate change the new model can be used as a tool for the prediction of climate change which is illustrated in two applications, on an underdispersed data on the monthly rainfall of Kerala, and an overdispersed data on the daily maximum temperature.

Thus this new model can be used in climate change studies which is an emerging area of interest in the context of global warming and outbreak of various tropical diseases like Dengue fever, Chikungunya etc. as well as untimely rains and floods causing irresponsible loss of agricultural crops and lives of human beings and animals. This is a challenging emerging area for future research.
CHAPTER 8. CONCLUSIONS

A COUNT MODEL BASED ON MITTAG-LEFFLER
INTERARRIVAL TIMES

K.K. Jose, B. Abraham

1. INTRODUCTION

The common regression model for the number of events in a given interval of
time (count data) used by most researchers is the Poisson model. The widespread
popularity of the Poisson model for count data arises from its simple derivation
as the number of arrivals in a given time period assuming exponentially distrib-
uted interarrival times. But of the many other count models that have been de-
veloped over the years, see (Wimmer and Altmann, 1999), very few share this
straightforward connection between a count model and its timing model equiv-
alent.

From the relationship between a count model and its timing process, a re-
searcher can develop a model using one form (timing or counting) but apply it
using the other. For example, marketing managers frequently collect interarrival
time data and make predictions of the number of arrivals (purchases) that a par-
ticular customer is likely to make over the next year.

The Poisson count model is valid only in the case where the data of interest
support the restrictive assumption of equi-dispersion, that is the conditional vari-
ance equals the conditional mean, but typically the conditional variance exceeds
the conditional mean (over-dispersion). There are also cases where the condi-
tional mean exceeds the conditional variance (under-dispersion). In either case,
the estimation based on Poisson model is inefficient and leads to biased inference
see (Winkelmann, 1995b). Thus the Poisson model becomes inadequate in most
of the econometric applications.

We assume that the waiting times between the events are independent but not
exponential (which would lead to the Poisson distribution for counts). Instead
they follow some other distribution with a nonconstant hazard function. If the
hazard function is a decreasing function of time, the distribution displays negative
duration dependence. If the hazard function is an increasing function of time, the
distribution displays positive duration dependence. In both cases, the conditional
probability of a current occurrence depends on the time since the last occurrence
rather than on the number of previous events. Events are dependent in the sense
Analysis of DAR(1)/D/s Queue with Quasi-Negative Binomial-II as Marginal Distribution

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Abstract

In this paper we consider the arrival process of a multiserver queue governed by a discrete autoregressive process of order 1 [DAR(1)] with Quasi-Negative Binomial Distribution-II as the marginal distribution. This discrete time multiserver queueing system with autoregressive arrivals is more suitable for modeling the Asynchronous Transfer Mode (ATM) multiplexer queue with Variable Bit Rate (VBR) coded teleconference traffic. DAR(1) is described by a few parameters and it is easy to match the probability distribution and the decay rate of the autocorrelation function with those of measured real traffic. For this queueing system we obtained the stationary distribution of the system size and the waiting time distribution of an arbitrary packet with the help of matrix analytic methods and the theory of Markov regenerative processes. Also we consider negative binomial distribution, generalized Poisson distribution, Borel-Tanner distribution defined by Frank and Melvin(1960) and zero truncated generalized Poisson distribution as the special cases of Quasi-Negative Binomial Distribution-II. Finally, we developed computer programmes for the simulation and empirical study of the effect of autocorrelation function of input traffic on the stationary distribution of the system size as well as waiting time of an arbitrary packet. The model is applied to a real data of number of customers waiting for check out in an airport and it is established that the model well suits this data.

Keywords: Discrete Autoregressive Process of Order [DAR(1)], Multiserver ATM Multiplexer, Matrix Analytic Methods, Markov Renewal Process, Markov Regenerative Theory, Teleconference Traffic, Quasi-Negative Binomial Distribution-II, Generalized Poisson Distribution, Borel-Tanner Distribution

1. Introduction

In B-ISDN/ATM network, IP packets or cells of voice, video, data are sent over a common transmission channel on statistical multiplexing basis. The performance analysis of statistical multiplexer whose input consists of a superposition of several packetized sources is not a straightforward one. The difficulty in modeling this type of traffic is due to the correlated structure of arrivals. A common approach is to approximate this complex non renewal input process by analytically tractable arrival process, namely discrete autoregressive process (DAR). The impact of autocorrelation in traffic processes on queueing performance measures such as mean queue length, mean waiting times and loss probabilities in finite buffers, can be very dramatic.

The DAR process, constructed and analyzed by Jacobs and Lewis [1] has developed into one of several standard tools for modelling input traffic in telecommunication networks. The discrete autoregressive process of order 1 [DAR(1)] is known to be a good model for VBR coded teleconference traffic as in Elwaid et al. [2]. Kanoun and Ali [3] modeled an ATM multiplexer as a discrete time multiserver queueing system with on-off sources and studied the transient and stationary distribution of the number of packets in the system. Hwang and Sohrah [4] obtained the closed form expression for the stationary probability generating function of the system size of the discrete time single server queue with DAR(1) input. Hwang et al. [5] obtained the waiting time distribution of the discrete time single server queue with DAR(1) input. Choi and Kim [6] analyzed a