On the Time Reversal of Markovian Arrival Processes

The contributions of this paper are the following: We derive a formula for the IDI (Index of Dispersion for Intervals) for the Markovian Arrival Process (MAP). We show that two-state MAPs with identical fundamental rate, IDI and IDC (Index of Dispersion for Counts), define interval stationary point processes that are stochastically equivalent; this is true for the time stationary point processes they define too. Special cases of the two-state MAP are frequently used as source models in the literature. The result shows that, fitting to the rate, IDC and IDI of a source completely determine the interval stationary and time stationary behavior of the two-state model. We give various illustrative numerical examples on the merits in predicting queueing behavior on the basis of first- and second-order descriptors by considering queueing behavior of MAPs with constant fundamental rate and IDC, respectively, constant fundamental rate and IDI. Disturbing results are presented on how different the queueing behavior can be with these descriptors fixed. Even MAPs with NO correlations in the counting process, i.e., IDC(t) = 1 are shown to have very different queueing behavior.

On the Use of Second-Order Descriptors To Predict Queueing Behavior of MAPs

The contributions of this paper are the following: We derive a formula for the IDI (Index of Dispersion for Intervals) for the Markovian Arrival Process (MAP). We show that two-state MAPs with identical fundamental rate, IDI and IDC (Index of Dispersion for Counts), define interval stationary point processes that are stochastically equivalent; this is true for the time stationary point processes they define too. Special cases of the two-state MAP are frequently used as source models in the literature. The result shows that, fitting to the rate, IDC and IDI of a source completely determine the interval stationary and time stationary behavior of the two-state model. We give various illustrative numerical examples on the merits in predicting queueing behavior on the basis of first- and second-order descriptors by considering queueing behavior of MAPs with constant fundamental rate and IDC, respectively, constant fundamental rate and IDI. Disturbing results are presented on how different the queueing behavior can be with these descriptors fixed. Even MAPs with NO correlations in the counting process, i.e., IDC(t) = 1 are shown to have very different queueing behavior.
Lower order moments of inter-transition times in the stationary QBD process

The epochs in which successive increases-or decreases-in the levels of a quasi birth-and-death process QBD process occur are of special interest. In queueing models they usually correspond to the times of successive increments or decrements. We derive general formulas for the variances of the times between successive increments or decrements in a stationary QBD process. In the case of the decrements we also obtain the variance of the time between an arbitrary decrement and the n-th subsequent decrement. These variances provide tractable descriptors of the relative variability of the input and output processes of queues that can be modeled as QBD processes.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Neuts, M. (Intern), Nielsen, B. F. (Intern)
Pages: 339-357
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Methodology and Computing in Applied Probability
Volume: 2
Issue number: 4
On the statistical implications of certain Random permutations in Markovian Arrival Processes (MAPs) and second order self-similar processes

In this paper, we examine the implications of certain random permutations in an arrival process that have gained considerable interest in recent literature. The so-called internal and external shuffling have been used to explain phenomena observed in traffic traces from LANs. Loosely, the internal shuffling can be viewed as a way of performing local permutations in the arrival stream, while the external shuffling is a way of performing global permutations. We derive formulas for the correlation structures of the shuffled processes in terms of the original arrival process in great generality. The implications for the correlation structure when shuffling an exactly second-order self-similar process are examined. We apply the Markovian arrival process (MAP) as a tool to investigate whether general conclusions can be made with regard to the statistical implications of the shuffling experiments. In Appendix A we show that, in principle, it is possible to derive MAP representations of the processes defined by shuffling a MAP in great generality.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Pages: 67-82
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Performance Evaluation
PH-distributions arising through conditioning

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Neuts, M. (Intern), Nielsen, B. F. (Intern)
Pages: 179-188
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Main Research Area: Technical/natural sciences

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Journal: Communications in statistics - Stochastic models
Similarity transformations of MAPs

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State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Barker, V. A. (Intern), Nielsen, B. F. (Intern)
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Main Research Area: Technical/natural sciences

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Journal: Mathematical Problems in Engineering
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  - Web of Science (2018): Indexed yes
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  - Scopus rating (2016): SJR 0.277 SNIP 0.482 CiteScore 0.77
  - Web of Science (2016): Indexed yes
  - BFI (2015): BFI-level 1
  - Scopus rating (2015): SJR 0.281 SNIP 0.541 CiteScore 0.74
  - BFI (2014): BFI-level 1
  - Scopus rating (2014): SJR 0.282 SNIP 0.582 CiteScore 0.79
  - Web of Science (2014): Indexed yes
  - BFI (2013): BFI-level 1
  - Scopus rating (2013): SJR 0.281 SNIP 0.849 CiteScore 1.14
  - ISI indexed (2013): ISI indexed yes
  - BFI (2012): BFI-level 1
  - Scopus rating (2012): SJR 0.336 SNIP 0.845 CiteScore 1.22
  - ISI indexed (2012): ISI indexed yes
  - BFI (2011): BFI-level 1
  - Scopus rating (2011): SJR 0.41 SNIP 0.709 CiteScore 0.92
  - ISI indexed (2011): ISI indexed yes
  - BFI (2010): BFI-level 1
  - Scopus rating (2010): SJR 0.232 SNIP 0.521
  - BFI (2009): BFI-level 1
  - Scopus rating (2009): SJR 0.253 SNIP 0.42
  - BFI (2008): BFI-level 1
  - Scopus rating (2008): SJR 0.315 SNIP 0.565
  - Scopus rating (2007): SJR 0.279 SNIP 0.499
  - Scopus rating (2006): SJR 0.241 SNIP 0.782
  - Scopus rating (2005): SJR 0.306 SNIP 0.72
  - Scopus rating (2004): SJR 0.274 SNIP 0.45
  - Scopus rating (2003): SJR 0.286 SNIP 0.523
  - Scopus rating (2002): SJR 0.4 SNIP 0.257
  - Scopus rating (2001): SJR 0.264 SNIP 0.646
  - Scopus rating (2000): SJR 0.234 SNIP 0.581
A Markovian approach for modeling packet traffic with long range dependence

We present a simple Markovian framework for modeling packet traffic with variability over several time scales. We present a fitting procedure for matching second-order properties of counts to that of a second-order self-similar process. Our models essentially consist of superpositions of two-state Markov modulated Poisson processes (MMPPs). We illustrate that a superposition of four two-state MMPPs suffices to model second-order self-similar behavior over several time scales. Our modeling approach allows us to fit to additional descriptors while maintaining the second-order behavior of the counting process. We use this to match interarrival time correlations.
Modeling and Simulation of Mixed Queueing and Loss Systems

General information
State: Published
Organisations: Department of Telecommunication, Department of Informatics and Mathematical Modeling, Budapest University of Technology and Economics
Authors: Fodor, G. (Ekstern), Blaabjerg, S. (Intern), Andersen, A. T. (Intern)
Pages: 253-276
Publication date: 1998
Main Research Area: Technical/natural sciences

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Web of Science (2017): Indexed yes
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Web of Science (2016): Indexed yes
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.272 SNIP 0.781 CiteScore 0.94
Web of Science (2015): Indexed yes
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.259 SNIP 0.88 CiteScore 0.96
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.288 SNIP 1.033 CiteScore 0.99
ISI indexed (2013): ISI indexed yes
Web of Science (2013): Indexed yes
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.271 SNIP 0.739 CiteScore 0.73
ISI indexed (2012): ISI indexed yes
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.315 SNIP 0.882 CiteScore 0.9
ISI indexed (2011): ISI indexed yes
Web of Science (2011): Indexed yes
BFI (2010): BFI-level 1
On the implications of certain random permutations of inter-arrival times or counts in a point process

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Publication date: 1998

Publication information
Publisher: Informatics and Mathematical Modelling, Technical University of Denmark, DTU
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200872
Publication: Research - peer-review › Report – Annual report year: 1998

On the significance of arrival process descriptions in packet traffic

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Pages: 1-12
Publication date: 1998

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Title of host publication: Nordic Teletraffic Seminar - 14
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Main Research Area: Technical/natural sciences
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On the significance of arrival process descriptors in packet traffic

General information
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Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
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Main Research Area: Technical/natural sciences
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On the statistical implications of certain random permutations of inter-arrival times or counts in a point process.

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Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
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Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

An application of superpositions of two-state Markovian sources to the modelling of self-similar behaviour

We present a modelling framework and a fitting method for modelling second order self-similar behaviour with the
Markovian arrival process (MAP). The fitting method is based on fitting to the autocorrelation function of counts a second
order self-similar process. It is shown that with this fitting algorithm it is possible closely to match the autocorrelation
function of counts for a second order self-similar process over 3-5 time-scales with 8-16 state MAPs with a very simple
structure, i.e. a superposition of 3 and 4 interrupted Poisson processes (IPP) respectively and a Poisson process. The
fitting method seems to work well over the entire range of the Hurst (1951) parameter.

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Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Pages: 196-204
Publication date: 1997

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advertising or promotional purposes or for creating new collective works for resale or redistribution to servers or lists, or to
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Source: orbit
A Partially Blocking-Queueing System with CBR/VBR and ABR/UBR Arrival Streams

General information
State: Published
Organisations: Department of Telecommunication, Department of Informatics and Mathematical Modeling, Ericsson Telecom AB, Budapest University of Technology and Economics
Authors: Blaabjerg, S. (Intern), Fodor, G. (Ekstern), Telek, M. (Ekstern), Andersen, A. T. (Intern)
Pages: 411-421
Publication date: 1997

Host publication information
Title of host publication: Proceedings from 5th International Conference on Telecommunication Systems
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Conference: 5th International Conference on Telecommunication Systems, Nashville, Tennessee, USA, 01/01/1997
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Source-ID: 168377
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

On the use of second order descriptors to characterize MAPs

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
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Publication date: 1997

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On the use of second order descriptors to characterize MAP

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Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Publication date: 1997
An application of superpositions of two-state Markovian sources to the modelling of self-similar behaviour.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Number of pages: 17
Publication date: 1996

Broadband Network Teletraffic: Final Report of Action COST 242

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Roberts, J. (ed.) (Ekstern), Mocci, U. (ed.) (Ekstern), Virtamo, J. (Ekstern), Andersen, A. T. (Intern)
Publication date: 1996

Reducing wide-band blocking by allowing wide-band calls to queue.

General information
State: Published
Organisations: Department of Telecommunication, Department of Informatics and Mathematical Modeling, Budapest University of Technology and Economics
Authors: Blaabjerg, S. (Intern), Fodor, G. (Ekstern), Andersen, A. T. (Intern)
Number of pages: 17
Publication date: 1996

Suerposition and Effective Bandwidth of Renewal Streams

General information
State: Published
Organisations: Department of Telecommunication, Department of Informatics and Mathematical Modeling, Mathematical Statistics
An experimental study of queueing performance of MAPs with apparently self-similar behaviour

Intercept and Asymptotic Behaviour of the nGI/G/1

Modelling and performance study of packet-traffic with self-similar characteristics over several timescales with Markovian Arrival Processes MAP
Modelling of apparently self-similar packet arrival processes with Markovian Arrival Processes MAP

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Jensen, A. (Ekstern), Nielsen, B. F. (Intern)
Publication date: 1995

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Publisher: IMM
Original language: English
Main Research Area: Technical/natural sciences
Source: orbit
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Publication: Research - peer-review › Report – Annual report year: 1995

Modelling of packet traffic with matrix analytic methods
The dissertation is concerned with modelling various performance aspects pertaining to packet switched telecommunication networks. The emphasis has been put on versatile modelling of the packet arrival process which is a very relevant issue in context with the future Broadband Integrated Service Data Network (B-ISDN). As a case study of packet switched networks Common Channel Signalling System No. 7 (SS7) has been used. SS7 is the packet switched network currently employed to command/control the public switched telephone network i.e. the setup and teardown of trunks and the basis for intelligent network services i.e. 800 and 900 calls and advanced mobile communication services. The Markovian Arrival Process (MAP) has been used as a versatile tool to model the packet arrival process. Applying the MAP facilitates the use of Matrix Analytic methods to obtain performance measures associated with for example the single server queue with a MAP arrival process and a general service time distribution. Measured SS7 traffic data has been analyzed as a part of this study. Recently there has been expressed concern regarding adverse behaviour of measured SS7 traffic i.e. long range dependence. Our studies did not reveal any adverse behaviour. In fact the observed traffic seemed very close to what would be expected from Poisson traffic. The Changeover/Changeback procedure in SS7, which is used to redirect traffic in case of link failure, has been analyzed. The transient behaviour during a Changeover scenario was modelled using Markovian models. The Ordinary Differential Equations arising from these models were solved numerically. The results obtained seemed very similar to those obtained using a different method in previous work by Akinpelu & Skoog 1985. Recent measurement studies of packet traffic from Local Area Networks (LAN) carried out at Bell Communications Research (Bellcore), New Jersey, have revealed behaviour very different from what conventional teletraffic models assume. In fact the observed traffic displays behaviour with (second order) self-similar characteristics over several time-scales. In this study we show that 8-16 state MAPs are able to capture this very variable behaviour over several timescales. The queuing behaviour of these MAPs has been analyzed with Matrix Analytic methods. The results correspond to those obtained by trace driven simulations of measured LAN traffic. It is shown that two arrival processes with the same first and second order properties of their counting processes can yield substantially different queueing behaviour. This illustrates that one should by very careful when trying to assess queueing behaviour from the first and second order properties of the arrival process. A heuristic formula for the tail behaviour of a single server queue fed by a superposition of renewal processes has been evaluated. The evaluation was performed by applying Matrix Analytic methods. The heuristic formula has applications in the Call Admission Control (CAC) procedure of the future BISDN network. The heuristic formula did not seem to yield substantially better results than already available approximations. Finally, some results for the finite capacity BMAP/G/1 queue have been obtained. The steady state probability vector of the embedded chain is found by a direct method where a modified LU factorisation scheme is employed. The standard LU factorisation scheme is modified so that all computations are done cancellation free and in a manner that exploits the special structure of the embedded chain yielding substantial computational savings. The queue-length at an arbitrary time is found by noting the close relationship with the expressions for the corresponding infinite queue. For the special case of a batch Poisson arrival process this observation makes it possible to express the queue length at an arbitrary time in terms of the corresponding queue lengths for the infinite case.

General information
State: Published
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Authors: Andersen, A. T. (Intern)
Number of pages: 242
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Original language: English
Statistisk undersøgelse af arbejdsbelastningen på en fødegang

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Authors: Andersen, A. T. (Intern), Grove, N. U. (Ekstern), Nielsen, B. F. (Intern)
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Main Research Area: Technical/natural sciences

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BFI (2016): BFI-level 1
Scopus rating (2016): CiteScore 0.02 SJR 0.11 SNIP 0.041
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.124 SNIP 0.077 CiteScore 0.03
BFI (2014): BFI-level 1
Scopus rating (2014): SJR 0.129 SNIP 0.116 CiteScore 0.05
BFI (2013): BFI-level 1
Scopus rating (2013): SJR 0.14 SNIP 0.122 CiteScore 0.06
ISI indexed (2013): ISI indexed no
BFI (2012): BFI-level 1
Scopus rating (2012): SJR 0.146 SNIP 0.15 CiteScore 0.08
ISI indexed (2012): ISI indexed no
BFI (2011): BFI-level 1
Scopus rating (2011): SJR 0.143 SNIP 0.157 CiteScore 0.1
ISI indexed (2011): ISI indexed no
BFI (2010): BFI-level 1
Scopus rating (2010): SJR 0.158 SNIP 0.169
Web of Science (2010): Indexed yes
BFI (2009): BFI-level 1
Scopus rating (2009): SJR 0.156 SNIP 0.201
BFI (2008): BFI-level 1
Scopus rating (2008): SJR 0.155 SNIP 0.17
Web of Science (2008): Indexed yes
Scopus rating (2007): SJR 0.147 SNIP 0.157
Web of Science (2007): Indexed yes
Scopus rating (2006): SJR 0.139 SNIP 0.163
Web of Science (2006): Indexed yes
Scopus rating (2005): SJR 0.142 SNIP 0.173
Scopus rating (2004): SJR 0.172 SNIP 0.209
Scopus rating (2003): SJR 0.145 SNIP 0.183
Statistisk analyse af arbejdsbelastning på en fødegang

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Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
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Publisher: IMM
Original language: English
Main Research Area: Technical/natural sciences
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Publication: Research - peer-review › Report – Annual report year: 1994

A transient queueing study of delay during changeover in the Message Transfer Part MTP

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Mathematical Statistics
Authors: Andersen, A. T. (Intern), Nielsen, B. F. (Intern)
Publication date: 1993

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Main Research Area: Technical/natural sciences
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Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 1993

Projects:

Evaluering og dimensionering af signalingssystemer for digitale kommunikationssystemer

Department of Informatics and Mathematical Modeling
Period: 01/11/1992 → 13/02/1996
Number of participants: 2
PhD Student:
Andersen, Allan T. (Intern)
Main Supervisor:
Nielsen, Bo Friis (Intern)

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Name of research programme: Gammel ordning u/skema-SU
Project: PhD