Dombry, Clément; **Kaj, Ingemar**

The on-off network traffic model under intermediate scaling. (English) Zbl 1235.60121
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The paper establishes an invariance principle for the normalized cumulative workload of a network with m on-off sources and time rescaled by a factor a. When both the number of sources m and the time scale a tend to infinity with a relative growth given by the so-called "intermediate connection rate" condition, the limit process is the fractional Poisson motion.

Reviewer: Oleg K. Zakusilo (Kyïv)

MSC:

60K10 Applications of renewal theory (reliability, demand theory, etc.)
60G22 Fractional processes, including fractional Brownian motion
60F05 Central limit and other weak theorems
60K05 Renewal theory
90B15 Stochastic network models in operations research
90B20 Traffic problems in operations research

Keywords:

on-off process; workload process; renewal process; intermediate scaling; fractional Poisson motion; fractional Brownian motion; Lévy motion; heavy tails; long-range dependence

Full Text: DOI

References:

[1] Asmussen, S.: Ruin Probabilities. World Scientific, Singapore (2000) · Zbl 0960.60003

[2] Beghin, L., Orsingher, E.: Fractional Poisson processes and related planar random motions. Electron. J. Probab. 14, 1790–1826 (2009) · Zbl 1190.60028 · doi:10.1214/EJP.v14-675

[3] Beghin, L., Orsingher, E.: Poisson-type processes governed by fractional and higher-order recursive differential equations. Electron. J. Probab. 15, 684–709 (2010) · Zbl 1228.60093 · doi:10.1214/EJP.v15-762

[4] Biermé, H., Estrade, A., Kaj, I.: Self-similar random fields and rescaled random balls models. J. Theor. Probab. 23, 1110–1141 (2010) · Zbl 1213.60096 · doi:10.1007/s10959-009-0259-x

[5] Billingsley, P.: Convergence of Probability Measures, 2nd edn. Wiley, New York (1968) · Zbl 0172.21201

[6] Bingham, N.H., Goldie, C.M., Teugels, J.H.: Regular Variation. Cambridge University Press, Cambridge (1987) · Zbl 0617.26001

[7] Mikosch, T., Resnick, S., Rootzen, H., Stegeman, A.: Is network traffic approximated by stable Lévy motion or fractional Brownian motion. Ann. Appl. Probab. 12(1), 23–68 (2002) · Zbl 1021.60076 · doi:10.1214/aoap/1015961155

[8] Mikosch, T., Samorodnitsky, G.: Scaling limits for cumulative input processes. Math. Oper. Res. 32(4), 890–918 (2007) · Zbl 1279.90033 · doi:10.1287/moor.1070.0267

[9] Gaigalas, R.: A Poisson bridge between fractional Brownian motion and stable Lévy motion. Stoch. Process. Appl. 116, 447–462 (2006) · Zbl 1087.60080 · doi:10.1016/j.spa.2005.10.003

[10] Gaigalas, R., Kaj, I.: Convergence of scaled renewal processes and a packet arrival model. Bernoulli 9(4), 671–703 (2003) · Zbl 1043.60077 · doi:10.3150/bj/1066223274

[11] Jumarie, G.J.: Fractional master equation: non-standard analysis and Liouville–Rieman derivative. Chaos Solitons Fractals 12, 2577–2587 (2001) · Zbl 0994.82062 · doi:10.1016/S0960-0779(00)00218-6

[12] Kaj, I.: Stochastic Modeling in Broadband Communications Systems. SIAM Monographs on Mathematical Modeling and Computation, vol. 8. SIAM, Philadelphia (2002) · Zbl 1020.94001

[13] Kaj, I.: Limiting fractal random processes in heavy-tailed systems. In: Levy-Lehel, J., Lutton, E. (eds.) Fractals in Engineering, New Trends in Theory and Applications, pp. 199–218. Springer, London (2005) · Zbl 1186.60018

[14] Kaj, I., Taqqu, M.S.: Convergence to fractional Brownian motion and to the Telecom process: the integral representation approach. In: Vares, M.E., Sidoravicius, V. (eds.) An Out of Equilibrium 2. Progress in Probability, vol. 60, pp. 383–427. Birkhäuser, Basel (2008) · Zbl 1154.60020

[15] Lévy, J.B., Taqqu, M.S.: Renewal reward processes with heavy-tailed interrenewal times and heavy-tailed rewards. Bernoulli

6, 23–44 (2000) · Zbl 0954.60071 · doi:10.2307/3318631

[16] Mainardi, F., Gorenflo, R., Scalas, E.: A fractional generalization of the Poisson processes. Vietnam J. Math. 32, 53–64 (2005) · Zbl 1087.60064

[17] Petrov, V.V.: Sums of Independent Random Variables. Springer, New York (1975) · Zbl 0322.60043

[18] Pipiras, V., Taqqu, M.S.: The limit of a renewal-reward process with heavy-tailed rewards is not a linear fractional stable motion. Bernoulli 6, 607–614 (2000) · Zbl 0963.60032 · doi:10.2307/3318508

[19] Pipiras, V., Taqqu, M.S., Lévy, L.B.: Slow, fast and arbitrary growth conditions for renewal reward processes when the renewals and the rewards are heavy-tailed. Bernoulli 10, 121–163 (2004) · Zbl 1043.60040 · doi:10.3150/bj/1077544606

[20] Resnick, S.I.: Heavy-Tail Phenomena, Probabilistic and Statistical modeling. Springer Series in Operations Research and Financial Engineering. Springer, New York (2007) · Zbl 1152.62029

[21] Taqqu, M.S., Willinger, W., Sherman, R.: Proof of a fundamental result in self-similar traffic modeling. Comput. Commun. Rev. 27, 5–23 (1997) · doi:10.1145/263876.263879

[22] Wang, X.-T., Wen, Z.-X.: Poisson fractional process. Chaos Solitons Fractals 18, 169–177 (2003) · Zbl 1042.60019 · doi:10.1016/S0960-0779(02)00579-9

[23] Wang, X.-T., Wen, Z.-X., Zhang, S.-Y.: Fractional Poisson processes (II). Chaos Solitons Fractals 28, 143–147 (2006) · Zbl 1086.60022 · doi:10.1016/j.chaos.2005.05.019

[24] Wang, X.-T., Wen, Z.-X., Fan, S.: Nonhomogeneous fractional Poisson processes. Chaos Solitons Fractals 31, 236–141 (2007) · Zbl 1137.60322 · doi:10.1016/j.chaos.2005.09.063