POWER-LAW TAILS AND UNIVERSALITY IN HUMAN DYNAMICS*

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Analysis [1]-[3] of empirical data sets for a variety of human activities such as web browsing, library usage, and the exchange of letters and e-mail messages, shows evidence that the distributions, $P(\tau)$, of waiting times τ between events (e.g., the time taken to respond to a letter or e-mail message), falls off algebraically with τ: $P(\tau) \sim \tau^{-\alpha}$, for large τ. The exponent α was reported to assume values close to 3/2 for the surface-mail correspondence of Darwin, Freud, and Einstein, while α was reported close to unity for data on e-mail, web browsing, and library visitation. Two simple models of continuous-priority queues, one with a variable-length queue and the other with a fixed-length queue, have been proposed to account for these results. The first model has been reported numerically [1]-[3] to yield $\alpha = 3/2$, while the second has been shown [1],[3],[4] to yield $\alpha = 1$. By mapping the first model onto the problem of biased diffusion, we derive the exact asymptotic results $P(\tau) \sim \tau^{-3/2}$ and $P(\tau) \sim e^{-\tau/\tau_0}\tau^{-5/2}$ for different parameter regimes. We also show that generalizing the second model to include two or more different types of activities changes the asymptotic behavior from $P(\tau) \sim 1/\tau$ to exponential decay of $P(\tau)$.

[1] A.-L. Barabási, Nature **435**, 207 (2005).
[2[J.G. Oliveira and A.-L. Barabási, Nature **437**, 1251 (2005).
[3] A. Vázquez et al., Phys. Rev. E **73**, 036127 (2006).
[4] A. Vázquez, Phys. Rev. Lett. **95**, 248701 (2005).