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Bursty Human Dynamics

 Springer

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*To Ábel, Lilla and Sophie;
To Ik-Sang Jo and Hyoung-Soon Ryu;
To Tuulikki; Juha, Tuomas, Annina and their
families.*

Preface

Bursty dynamics is a common temporal property of various complex systems in nature but it also characterises the dynamics of human actions and interactions. At the phenomenological level, it is a feature of all systems that evolve heterogeneously over time by alternating between periods of low and high event frequencies. In such systems, bursts are identified as periods in which the events occur at a rapid pace within a short time-interval while these periods are separated by long periods of time with low frequency of events. As such dynamical patterns occur in a wide range of natural phenomena, their observation, characterisation and modelling have been a long-standing challenge in several fields of research. However, due to some recent developments in communication and data collection techniques, it has become possible to follow digital traces of actions and interactions of humans from the individual up to the societal level. This led to several new observations of bursty phenomena in the new but largely unexplored area of human dynamics, which called for the renaissance to study these systems using research concepts and methodologies, including data analytics and modelling. As a result, a large amount of new insight and knowledge as well as innovations have been accumulated in the field, which provided us a timely opportunity to write this brief monograph to make an up-to-date review and summary of the observations, appropriate measures, modelling and applications of heterogeneous bursty patterns occurring in the dynamics of human behaviour.

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Contents

1	Introduction	1
1.1	Bursty Human Dynamics	4
1.2	About This Monograph	6
2	Measures and Characterisations	7
2.1	Point Processes as Time Series with Irregular Timings	8
2.1.1	The Poisson Process	9
2.1.2	Characterisation of Temporal Heterogeneities	9
2.2	Inter-event Time, Residual Time, and Waiting Time	18
2.3	Collective Bursty Phenomena	19
2.3.1	Bursty Patterns in Egocentric Networks	20
2.3.2	Bursty Temporal Motifs	23
2.3.3	System Level Characterisation	25
2.4	Cyclic Patterns in Human Dynamics	25
2.4.1	Remark on Non-stationarity	28
3	Empirical Findings in Human Bursty Dynamics	31
3.1	Individual Activities	31
3.2	Interaction-Driven Collective Activities	32
3.2.1	Face-to-face Interactions	35
3.2.2	Mobile Phone-Based Interactions	36
3.2.3	Communication by Posted Letters and Emails	39
3.2.4	Web-Based Activities and Social Interactions	40
3.3	Other Bursty Patterns	43
3.3.1	Financial Activities	43
3.3.2	Human Mobility	44
3.3.3	Animal Behaviours	46
4	Models and Mechanisms of Bursty Behaviour	47
4.1	Models of Individual Activity	47
4.1.1	Queuing Models of Bursty Phenomena	47

4.1.2	Memory Driven Models of Bursty Phenomena	53
4.1.3	Poisson Models of Bursty Phenomena	57
4.1.4	Other Type of Models	62
4.2	Models of Link Activity	64
4.2.1	Interacting Priority Queues	64
4.2.2	Models with Combined Mechanisms	65
4.3	Network Models of Bursty Agents	66
4.3.1	Zero-Crossing Random Walk Model	66
4.3.2	Reinforcement Models of Group Formation	67
4.3.3	Evolving Networks with Interacting Priority Queues	67
4.3.4	Dynamic Networks with Memory	68
4.3.5	Activity Driven Network Models with Bursty Nodes	69
5	Dynamical Processes on Bursty Systems	73
5.1	Bursty Characteristics Controlling Dynamical Processes	74
5.1.1	Inter-event Time and Residual Time Distributions	74
5.1.2	Triggered Event Correlations	83
5.1.3	Effects of Link Burstiness	84
5.1.4	Other Bursty Characters	85
5.1.5	Dominant Characters	86
5.2	Dynamical Processes on Bursty Temporal Networks	88
5.2.1	Epidemic Spreading	88
5.2.2	Random Walks	91
5.2.3	Threshold Models	94
5.2.4	Evolutionary Games	95
5.2.5	Dynamical Process Induced Bursty Behaviour	96
6	Discussion	99
6.1	Future Directions and Methodological Approaches	102
	Erratum to: Bursty Human Dynamics	E1
	References	105
	Index	119

Acronyms

This non-complete list of acronyms only collects the most frequently used notations in the text.

t	Time or timing
t_i	Timing of the i th event
n	Number of events
T	Total observation period
$x(t)$	Binary signal of a point process
Δt	Time window for event adjacency
t_0	First observation time
τ	Inter-event time
$P(\tau)$	Inter-event time distribution
$\langle \tau \rangle$	Average inter-event time
σ	Standard deviation of $P(\tau)$
α	Exponent of inter-event time distribution
$x_i(t)$	Interaction sequence of an individual i
$\tau^{(i)}$	Inter-event time in sequence $x_i(t)$
a_i	Activity (number of actions) of an individual i
$x_{ij}(t)$	Interaction sequence between individuals i and j
$\tau^{(ij)}$	Inter-event time in sequence $x_{ij}(t)$
$A; A_i$	Group of individuals; the set of neighbours of an individual i
$x_A(t)$	Interaction sequence between individuals in the group A
$\lambda; \lambda(t)$	Event rate; time-dependent event rate
τ_c	Cutoff of inter-event time distribution
B	Burstiness parameter
E	Bursty train size
$P_{\Delta t}(E)$	Bursty train size distribution
β	Exponent of bursty train size distribution
t_d	Delay time
$A(t_d)$	Autocorrelation function

γ	Exponent of autocorrelation function
τ_w	Waiting time
α_w	Exponent of waiting time distribution
τ_r	Residual time
M	Memory coefficient
N	Network size
L	Number of links in a static network
k	Node degree