TITLE: What makes us tick: looking for invariants in the bursty dynamics of interaction networks - human, animal, computer, and brain networks.

ABSTRACT: This is an interdisciplinary project whose goal is establishing whether there exist certain statistical invariants in the bursty dynamics observed in complex network where nodes interact pair-wise or otherwise among themselves. Current results in this direction indicate that such invariants (such as certain universal statistical features exhibited by all the interacting nodes) indeed exist for instance in human dynamics [1-4], and specifically in written communication across various different media (paper letters, emails, text messages), see [1-3].

Modelling by means of queueing theory [1-3] has suggested reasons why certain mathematical constraints might be at the origin of some such universal features empirically observed in interaction networks. As an example, when a suitable activity-based proper time is introduced [2-3], the response-time distributions of writing agents follow a common power-law decay with exponent near -3/2. This universal behavior is line with analytical and numerical results based on priority-queue modelling [2-3].

However, it has not yet been established whether such universality holds for instance also for the inter-event-time distribution of agents, i.e. for the distribution of the pauses in each individual agent's activity. One first goal of this project is thus establishing whether inter-event-time universality may exist, across many different classes of agents (extensive datasets for human, animal, and computer activity are already available and ready to be analyzed; as a project activity, we expect to be able to collect also suitable interaction data concerning brain networks and other networks relevant in the neurosciences). Modelling hypotheses underlying these possible effects, based on the interaction of competing agent-based queues, have also been preliminarily explored. They will be developed together with data analysis during the project.

Moving away from the analysis of temporal heterogeneities, another possible type of universality regards the existence of Zipfian distributions in the interaction volumes pertaining to each agent. Again, preliminary analyses [5] do point to the existence of universal bimodal Zipf-type volume distributions for agents. Also in this case modeling and further data analysis will be developed in a parallel fashion. An interesting point is that available data, for instance regarding email correspondence, can also be analyzed and modelled from the point of view of the interaction among network meta-agents, such as email-processing computer servers [5]. This might point to other forms of activity invariance across network scales.

The above proposed work concerns the analysis and modelling of network dynamics at the local level of the individual interacting agents (or meta-agents). A long-term goal in this project would then be the investigation also of network-level dynamical models whereby the observed node-level (possibly universal) patterns self-organize as a consequence of optimality or other principles which might be at work at the global network level.

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EXPERIMENTAL DATA:

To be acquired	x
Already acquired (ready to be used)	x

Ethics committee:

Obtained	
Conditioned submission*	
Not required	X

* request will be submitted only if a PhD student will be associated to the project