Multivariate Self-Exciting Processes with Dependencies and application to cyber loss processes

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We introduce the class of multidimensional self-exciting processes with dependencies (MSPD), which is a unifying writing for a large class of processes: counting, loss, intensity, and also shifted processes. The framework takes into account dynamic dependencies between the frequency and the severity components of the risk, and therefore induces theoretical challenges in the computations of risk valuations. We present a general method for calculating different quantities related to these MSPDs, which combines the Poisson imbedding, the pseudo-chaotic expansion and Malliavin calculus. The methodology is illustrated on cyber loss process and the computation of cyber stress scenarios, based on the accumulation of claims or vulnerabilities.