UCD Research Demonstrator PhD Project

Multivariate Count Time Series Models

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An increasing interest in the modeling of count time series data has been observed, especially due to the many possible areas of applications such as medicine, health, sociology, economics, epidemiology, and engineering, just to name a few. Univariate count time series models based on hidden Markov chains, INteger-valued AutoRegressive (INAR), and INteger-valued Generalised AutoRegressive Conditional Heteroskedastic (INGARCH) approaches have been introduced and explored in the literature.

Multivariate extensions of such approaches have been proposed, but several limitations have yet to be addressed. As discussed by Cameron & Trivedi (1998), Jung, Liesenfeld and Richard (2011), and Karlis (2016), models for multivariate count time series are rather sparse mainly due to the analytical and computational challenges.

This project consists of developing novel multivariate time series models for dealing with counts that (i) capture cross-dependencies among different components; and (ii) account for marginal features like underdispersion, overdispersion, zero-inflation/deflation, and heavy-tailedness. In particular, we will consider a multivariate INGARCH-based approach. Some recent multivariate INGARCH models are due to Cui & Zhu (2018), Cui, Li & Zhu (2020), Fokianos et al. (2020), Piancastelli, Barreto-Souza & Ombao (2023), and Jang, Sundararajan & Barreto-Souza (2023).

Topics to be explored in this project are:

- Multivariate formulations based on different approaches with a particular focus on the INGARCH method.
- Establishment of properties such as stationarity and ergodicity of the multivariate count time series models.
- Inference is going to be a challenge and methods such as composite likelihood and EM-algorithm will be essential.
- Study of the asymptotic properties of proposed estimators.

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- `R` implementation and numerical experiments to provide empirical evidence of consistency and scalability.
- Applications in different areas such as healthcare and econometrics.

This project is suitable for students with a solid background in Statistics and Mathematics, good coding skills, and of course with special interest in Time Series Analysis. It is also desirable for the selected student to be strongly motivated to do research.

References

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