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## Fuzzy jump models for soft and hard clustering of mixed-type multivariate time series

Statistical jump models have been recently introduced to detect persistent regimes by clustering temporal features while discouraging frequent regime changes. However, they rely on hard clustering and therefore do not account for uncertainty in state assignments.

In this work, we propose a fuzzy extension of the statistical jump model that incorporates uncertainty in cluster membership. Leveraging the similarities with the fuzzy *c*-means framework, the proposed *fuzzy jump model* sequentially estimates time-varying state probabilities. The approach is flexible, as it encompasses both soft and hard clustering through a fuzziness parameter and naturally accommodates multivariate time series of mixed type.

Through extensive simulation studies, we show that the proposed method accurately recovers the latent state distribution and outperforms competing approaches in scenarios with high assignment uncertainty. We further illustrate its practical relevance on real data from celestial mechanics, addressing the identification of co-orbital regimes in the three-body problem, with implications for asteroid dynamics and space mission design.

### Special/ Invited session

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### Classification

Both methodology and application

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