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Analysis of time series recurrence and cross recurrence in the relationship of climate with Coffee Leaf Rust

Ana M. Tarquis[1,2], Emmanuel Lasso[3], Juan Carlos Corrales[3], and Elias de Melo[4]
[1]Grupo de Sistemas Complejos, Universidad Politécnica de Madrid, Spain
[2]CEIGRAM, Universidad Politécnica de Madrid, Spain
[3]Telematics Engineering Group, Universidad del Cauca, Popayán, Colombia
[4]CATIE, 7170 Turrialba, Costa Rica

Agroindustry in South and Central America is positioned as a traditional production sector, where exists a need for integration of processes for the implementation of contingency measures in a timely manner against events that create a risk for crops. Diseases affecting agricultural sectors are often closely related to weather conditions and crop management. In particular, for the coffee production, the Coffee Leaf Rust (CLR) is a disease that affects quality and production costs for farmers greatly.

Detecting the patterns that affect the disease can lead to early actions that lessen its impact. In this sense, some researchers in the sector have focused their efforts on determining over time the relationships between weather conditions and agronomic properties of crops with episodes of epidemics of diseases as coffee rust.

Different natural processes, such as the climate, can have different and recurrent behaviors in time. Despite its periodicity, climate change has impacted on recurring events, both in their temporality and intensity. Thus, climate variables have properties of dynamic deterministic or nonlinear systems. The recurrence analysis of states in these systems is one of the solutions to carry out a study of their behavior in the time-domain. Eckmann et al. proposed the Recurrence Plots (RP) for the visualization of state recurrence, allowing to see the space phase trajectories in a bidimensional representation. This analysis, initially applied to a single time series and its recurrence with itself, can also be extended to compare two time series by Cross Recurrence Plots (CRP) and find the recurrence between them. Moreover, the elements of PR and CRP can be quantified, obtaining direct elements of comparison between series or pairs of time series.

The aim of this analysis was to find the times and conditions in which the time series of the climatic variables present events related to anomalies or extreme values in the CLRI time series. In addition, the recurrence analysis allows to know the time delay for which each climatic variable affects the disease.

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