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Characterization of mango tree patchiness using a tree-segmentation/clustering approach

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⁴ MISTIS - Modelling and Inference of Complex and Structured Stochastic Systems

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Abstract :

****Research focus****: Like many other tropical trees, mango tree is characterized by strong phenological asynchronisms between and within trees, entailing patchiness. Patchiness is characterized by clumps of either vegetative or reproductive growth units (GUs) within the canopy: while some parts of the tree canopy develop vegetative GUs, others may remain in rest or produce inflorescences at the same time. These asynchronisms concern more or less large branching systems. The objective here is to define statistical methodology to identify and characterize patchiness patterns.

****Methods****: Tree-indexed data are used as plant architecture representations and it is assumed that patches can be assimilated to a partition of tree-indexed data into subtrees. It is therefore assumed that there are subtrees within which the characteristics of the botanical entities follow the same or nearly the same distribution and between which these characteristics have different distributions. The detection of such subtrees can thus be stated as tree-indexed data segmentation. This is the analog of the sequence segmentation problem in the context of tree-indexed data. The output of the segmentation procedure is a partition of trees such that each subtree is different from each other while two non-adjacent subtrees can be very similar. We therefore propose a two-stage tree segmentation/clustering algorithm based on the previous segmentation procedure combined with a mixture model in order to group non-adjacent similar subtrees. The mango trees were located in the experimental orchard of the CIRAD research station in Saint-Pierre, Réunion Island. Five mango trees were described at the GU scale for 7 cultivars (Cogshall, Jose, Kensington Pride, Irwin, Kent, Nam Doc Mai, Tommy Atkins). These trees were fully described for 2 growth cycles.

****Results****: The patches detected using the tree segmentation/clustering algorithm had various compositions and sizes. The empirical distributions of patch size were used to compare cultivar behaviours. Irwin had the largest patches, in contrast to Tommy Atkins that had the smallest patches. Jose was the cultivar with the most heterogeneous patch sizes. Maximum a posteriori assignment of subtrees to clusters yields information about patch type distributions in cultivars. The most marked differences concerned Tommy Atkins, which had only 2 categories of patches, with flowering patches being quasi-absent and partly compensated by a significant proportion of flowers in resting patches.

****Conclusions****: We here propose a new approach for characterizing mango tree patchiness. This enabled to compare the phenology and architecture of mango cultivars on a more objective

basis. One strength of this approach is the representation of non-local dependencies within tree-indexed data. This is a mandatory property for identifying patchiness patterns at various scales within trees and we expect numerous application of this new paradigm for analysing tree-indexed data.

Keywords :

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