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MODELING CITY TREE GROWTH WITH ARTIFICIAL INTELLIGENCE AND MULTIVARIATE STATISTICS FOR SUSTAINABLE URBAN ECOSYSTEMS

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ABSTRACT Trees form the main natural element of the urban landscape. However, the urban environment induces severe ecological conditions that impair tree growth and survival. To adequately preserve arboreal heritage and warrant a sustainable ecosystem, an analytical model that express street tree growth and define efficient urban tree inventory procedures needed to be developed. To fulfill these objectives, an ecological engineering research project was designed. Using multiple abiotic and biotic variables, data were collected on 1532 trees in five different urban ecological zones of Montréal (Québec, Canada). Seven species representing 75% of the street tree population were sampled. To define the analytical model, artificial intelligence algorithms and multivariate statistics were used synergistically. It was discovered that a combination of eleven dendrometric parameters gave an adequate portrayal of tree physiological stages. Second, the analysis unveiled links between environmental factors and tree growth. Third, artificial neural networks (ANNs) trained under supervised learning recognized tree growth patterns. For most species, growth-cluster prediction on unseen test files ranged from 80% to almost 100%. Finally, for input data typical of aerial lidar laser measurements, multilayer perceptron networks were used to predict the value of essential tree morphological parameters with surrogate variables, and performed well. Overall, the average Pearson *r* coefficient value for all simulations was 91%. Despite different age-class distribution of trees, dissimilar morphological characteristics, and uneven species partition within urban ecological zones, ANNs and multivariate statistics algorithms demonstrated robustness and predictive capability. It is suggested that they become important analytical components of street-tree management plans.

Keywords: Artificial neural networks, Classification prediction, Decision support systems, LIDAR laser, Multidimensional statistical analysis, Tree morphological parameters prediction, Urban ecological conditions, Urban tree growth modeling, Urban tree inventory.