Extreme Learning Machine with Particle Swarm Optimization for Agricultural Tillage Practices Mapping

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Conservational tillage practices can reduce negative impacts on soil and water while increasing yield through less surface disturbance and more crop residues. There has been a high demand for crop tillage practices mapping in precision agricultural management and appraisal. The current method to map crop tillage practices is mainly with field investigations, which is labor-costing, time-consuming, subjective, and difficult to generate widely distributed survey data. Remote sensing technology can provide a more rapid, accurate, and objective solution. However, tillage assessment requires collection of data from immense areas within a small amount of time. Even at the county scale, complete tillage survey requires assessment of thousands of fields within a short interval between soil preparation and crop emergency. This calls for fast data analytics. This project proposed an efficient classifier, kernel extreme learning machine (KELM), for mapping tillage practices from airborne hyperspectral remote sensing imagery. The KELM can outperform other machine learning algorithms (e.g., support vector machine, random forest) in terms of accuracy and speed. However, it was also sensitive to parameters as other algorithms, which can be disadvantageous in real world applications. To further improve its efficiency, particle swarm optimization (PSO), an evolutionary optimization technique, was proposed to search for optimal parameters in a high-dimensional solution space with no closed-form mathematical expression. The optimized KELM model offered the best performance without exhaustive parameter tuning and is suitable for applications in contemporary agriculture, such as tillage practices mapping, crop residue percentage estimation, and soil quality assessment.

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